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Does Socioeconomic Status Moderate the Associations Between Theory of Planned Behaviour Variables and Health Promoting Dietary Behaviour? A Systematic Review and Meta-Analysis

by

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Statement of Sources

I declare that this report is my own original work and that contributions of others have been duly acknowledged.

Date: 13/10/2016

Signed: ………………………..

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Abstract

Dietary behaviours are strongly patterned by socioeconomic status (SES). However, the role of SES in the self-regulation of health promoting dietary behaviour is not fully understood. This systematic review with meta-analysis investigated whether four individual-level measures of SES (income, occupation, education and race) moderate the relationships between Theory of Planned Behaviour (TPB) variables and health promoting dietary behaviour in adults. A systematic literature search identified 65 studies from 51 articles providing information on TPB variables, SES and health promoting dietary behaviour. Random-effects meta-analyses were conducted to generate pooled correlations corrected for sampling and measurement error. Results showed that all TPB variables were significantly associated with health promoting dietary behaviour, with intention having the strongest correlation with behaviour (21% of variance explained), followed by perceived behavioural control (PBC) (11%) attitude (7%) and subjective norm (2%). Random-effects meta-regression was used to investigate the moderating effects of individual-level measures of SES on these correlations. Results showed that none of the SES indicators were significant moderators of the relationship between TPB variables and health promoting dietary behaviour. These results suggest that associations between social-cognitive predictors and healthy dietary behaviour are not patterned by individual-level SES measures.

Poor diet has been identified as the leading cause of premature death and disability worldwide (Global Burden of Disease, 2016). This is because consuming an unhealthy diet and failing to meet dietary guidelines for fruit and vegetable intake increases one's risk of developing obesity, hypertension and high cholesterol (Moodie, Tolhurst, & Martin, 2016). This in turn increases one's risk of developing noncommunicable diseases (NCDs) such as diabetes, cancer and cardiovascular disease (Darmon & Drenowski, 2008; Hung et al., 2004; Oyebode et al., 2014). NCDs account for over two-thirds of global deaths per year (World Health Organisation, 2014) and in Australia NCDs are responsible for 9 out of every 10 deaths (Moodie, Tolhurst, & Martin, 2016). A healthy diet rich in fruit and vegetables is one of the most important factors in protecting against chronic diseases (National Health and Medical Research Council [NHMRC], 2013). However, socioeconomic disparities in diet are well recognised (Appelhans et al., 2012; Darmon & Drewnowski, 2008; Darmon & Drewnowski, 2015; Giskes et al., 2010). The overall evidence suggests that groups with higher socioeconomic status (SES) (e.g. better education, higher income) are more likely to consume healthy diets compared to those with low SES (Darmon & Drewnowski, 2008; Mayen et al., 2014; Nakamura et al., 2016, Pechey et al., 2015). Understanding the mechanisms underlying these social inequalities in diet is vital in order to develop effective strategies and behavioural change interventions to reduce diet-related health inequalities.

Health promoting dietary behaviour refers to any dietary choice or behaviour conducive to reducing the risk of chronic disease (NHMRC, 2013). The Australian Dietary Guidelines (NHMRC, 2013) recommend that individuals "enjoy plenty of vegetables including different types and colours, and legumes/beans, and enjoy fruit"

(p. 36) and "limit intake of foods containing saturated fat, added salt, added sugars ..." (p. 67). This translates to two serves of fruit and five serves of vegetables each day, while at the same time limiting discretionary food to one or less serves per day (NHMRC, 2013). However, research shows that many Australians do not meet the recommended intake of fruits and vegetables (Australian Bureau of Statistics [ABS], 2014). For example, only 6.8% of Australians meet the recommended daily intake of vegetables, and just over half of the population meet the recommended daily intake of fruit (ABS, 2014). Research suggests that the majority of those who do not meet recommendations come from low SES groups (McNaughton et al., 2008). This socioeconomic gradient of diet quality has been found in most industrialised countries, including the U.S. (Kant et al., 2007), U.K. (Northstone & Emmet, 2010) France (Malon et al., 2010), Belgium (Mullie et al., 2010) and Finland (Lallukka et al., 2007).

Socioeconomic Status

The relationship between SES and diet is multifaceted, influencing food choices and behaviours through various mechanisms and pathways. SES can be understood as one's social standing within the social hierarchy and one's access to material and social resources (American Psychological Association [APA], 2007). SES is often measured by ranking people according to the combination of their educational attainment, occupational status and income (APA, 2007). In addition to SES being measured at an individual-based level, SES can also be measured at an area-based level, such as area of residence or geographic location. However, individual-based level indicators are typically more sensitive than area-based measures, showing stronger associations with health outcomes compared to area-level SES proxy measures (Pardo-Crespo et al., 2013).

Education, income and occupation are all important indicators of the types of resources individuals hold. Consequently, differences in these indicators can lead to inequalities in access to resources that may affect one's ability to engage in health promoting dietary behaviours (Darmon & Drewnoksi, 2008). Race is also recognised to influence one's SES as income, occupation and education vary by race and result in differential access to resources within society (House & Williams, 2000; Liberatos, Link, & Kelsey, 1988). Although education, income, occupation and race are related and appear to have similar effects, these different facets of SES have independent influences on diet (Galobardes, Morabia, & Bernstein, 2001; Turrell et al., 2003).

Education

Evidence shows that higher educational attainment is associated with increased fruit and vegetable intake and less consumption of energy-dense foods (Hong, Kim, & Kim, 2012; Konttinen, et al., 2012; Miura, Giskes, & Turrell, 2012). One way in which educational attainment may affect dietary choices is by influencing one's health literacy; that is, one's ability to access and use information in order to promote and maintain good health (Australian Institute of Health and Welfare [AIHW], 2012). The Australian dietary guidelines (NHMRC, 2013) suggest that low levels of food health literacy may prevent compliance with the dietary guidelines. For example, if an individual has a low level of educational attainment this may inhibit their ability to search for and understand nutrition education messages or read food labels (Macario et al., 1998). It has also been suggested that better educated individuals may make better-informed decisions about the risks and benefits of various diet choices (Allan, Sniehotta, & Johnston, 2013). They may also make better structured and more realistic plans for achieving healthy eating habits (Allan, Sniehotta, & Johnston, 2013).

In addition to education influencing health literacy, there also appears to be an association between education and nutrition knowledge, with tertiary degree holders having the highest levels of nutrition knowledge (Hendrie et al., 2008). A study conducted by Wardle et al. (2000) examining the relationship between dietary behaviour and nutrition knowledge found that those who had higher levels of nutrition knowledge were 25 times more likely to meet the recommended daily intake of fruit and vegetables (Wardle et al., 2000). Similarly, McKinnon, Giskes and Turrel (2013) found that high levels of nutrition knowledge (especially awareness of the link between diet and disease) is associated with healthy diets, and that high SES groups have the highest levels of such knowledge.

Education regarding food preparation, cooking skills and techniques can also influence what one eats. Research suggests that food management skills are essential in order to translate nutrition knowledge into healthy dietary behaviour (Hartmann, Dohle, & Siegrist, 2013). Cooking skills have been shown to be positively correlated with vegetable consumption and negatively correlated with fast food consumption in adults (Hartmann, Dohle, & Siegrist, 2013). This suggests that the more knowledge one has about how to prepare and cook food, the more likely one is to make healthy food choices.

Income

In addition to education, income can also affect food choices and dietary behaviours. It is well documented that a healthy nutritionally balanced diet costs more than an unhealthy nutrient poor diet (Darmon & Drewnowski, 2015). Unhealthy foods made from refined and processed grains, added sugar, salt and fat are generally cheaper per calorie than nutrient-dense healthy foods (Maillot et al., 2007). Those from low socioeconomic backgrounds may have less financial resources available to spend on healthy foods thus creating a barrier to maintaining a healthy diet (Bertoni, Foy & Hunter, 2011; Drewnowski & Darmon, 2005). A recent systematic review (Darmon & Drewnowski, 2015) found that high SES groups consume healthier and more expensive diets and low SES groups tend to select cheaper more energy dense diets lacking in fruit and vegetables. The authors concluded that socioeconomic gradient of dietary behaviours may be due to healthier diets being more expensive (Darmon & Drewnowski, 2015).

Research has shown that in Australia, a healthy diet costs average-income families approximately 20% of their disposable income compared to 28%-40% for the lowest-income families (Lee et al., 2016). A 2011 survey found 13% of Australians cannot afford to eat nutritionally balanced healthy meals (Lockie & Peitsch 2012). Those dependent on welfare are especially vulnerable. According to Kettings, Sincalir and Voevodin (2009) welfare dependent Australians are less likely to buy and consume healthy food due to the associated costs. Furthermore, a study conducted by Thornton (2010) showed that increased fast food purchasing is independently associated with decreased household income. Therefore, even if one aims to eat a healthy diet, financial constraints may limit one's ability to do so.

Income also influences where people live and this is implicated in food and supermarket availability (Powell et al., 2007). For example, Australians residing in wealthy and more affluent neighbourhoods have greater access to and a wider range of supermarkets and fruit and vegetables within two kilometres of their home and report spending more on such foods compared to those from poorer neighbourhoods (Ball et al., 2009). Low-income neighbourhoods are also disproportionality more exposed to fast food restaurants (Fleischhacker et al., 2011). The marketing and advertising of unhealthy food has also been found to be disproportionately targeted at low-income neighbourhoods (Cassady et al., 2015).

Occupation

The socioeconomic patterning of dietary behaviour may also be influenced by occupation. It has been demonstrated that those from lower status jobs consume less vegetables and more fried foods, refined grains and sugar than those from high status jobs (Galobardes, Morabia, & Bernstein, 2001). Occupation may influence diet in a variety of ways. Firstly, it is important to recognise that occupation is closely linked to educational attainment in terms of employability and consequently one's income (e.g. higher status jobs associated with higher income). However, occupation may also influence diet through work-based cultures and social networks (Galobardes, Morabia, & Bernstein, 2001). The nature of certain occupations themselves may also affect dietary behaviours. For example, shift workers and truck drivers are at an increased risk of having a poor diet due to their work environments and less food accessibility (Vayro & Hamilton, 2016; Zhao & Turner, 2008). The recent CSIRO Healthy Diet Score 2016 report found that in Australia, construction workers eat 76% more discretionary foods than health industry workers (Hendrie et al., 2016).

Occupation can influence food choices by impacting on time available to plan, shop and prepare meals and also by affecting stress and fatigue levels (Devine et al., 2006). Time-pressured working parents have been found to consume more takeaways and less home-cooked meals in order to cope with the stress and reduce time and effort for meals (Devine et al., 2006).

In addition to occupational status, employment status can also influence dietary choices and behaviour. In Australia, the unemployed are at an increased risk of having poor quality diets (Hendrie et al., 2016). This may be due to the fact that the unemployed are more likely to experience "food insecurity;" (i.e. limited access to nutritionally adequate and safe foods) (Burns, 2004).

Race

Diet inequalities also appear to be influenced by race. Research has shown that in Australia, Aboriginal and Torres Strait Islander people are at an increased risk of not meeting dietary guidelines for fruit and vegetable consumption compared to non-indigenous Australians (ABS, 2015; NHMRC, 2013). For example, only 4.4% of Aboriginal and Torres Strait Islanders aged 19 years and over meet the recommended daily vegetable consumption compared to 6.8% of non-indigenous Australians (ABS, 2015). Aboriginal and Torres Strait Islanders also report lower daily fruit intake compared to the non-indigenous population (ABS, 2015). However, this discrepancy is likely to be influenced by living in remote areas. Similarly, in the U.S.A., African American and other minority racial groups tend to consume less fruit and vegetables compared to Caucasians (Dubowitz et al., 2008). This may be partly due to environmental factors such as supermarket availability varying between African American, Hispanic and White neighbourhoods (Powell et al., 2007). However, the relationship between diet and race is complex, as minority racial groups also tend to have higher levels of unemployment and lower income (Krieger, Williams, & Moss, 1997).

Behavioural Determinants of Diet Inequalities

Numerous epidemiological and sociological studies have demonstrated SES-related differences in dietary behaviours patterned by education, income, occupation and race. However, the majority of this research has been descriptive, focusing on the nature, extent and direction of such inequalities; it does not explain the mechanisms underlying these behavioural differences. The different pathways and processes linking the SES indictors of education, occupation, income and race with dietary behaviours clearly have implications for public health policy and interventions. It is essential to further understand this issue in order to develop effective dietary interventions that promote healthy eating and reduce the widespread disparities in meeting dietary guidelines. If disparities in dietary choices and behaviours can be observed between different SES groups, it follows that differences in the effect of behavioural predictors may be able to explain why diet related disparities exists between different SES groups. According to Blair and Raver (2012) SES can influence one's health cognitions, including intentions, perceived behavioural control (PBC) and attitudes. Therefore, adopting a psychosocial model framework, such as the Theory of Planned Behaviour (TPB) may provide clues to why diet related disparities exist between different SES groups.

TPB and Eating Behaviour

Behavioural theories and conceptual models provide a theoretical framework that outlines the determinants of individuals' dietary behaviour and provides the basis for understanding dietary behaviours. The TPB (Ajzen, 1991) is one of the most widely used social cognition models that attempts to explain health behaviours (McEachan et al., 2011), and is also the most frequently used theory in health promotion interventions (Glanz & Bishop, 2010). The TPB is a parsimonious model of behaviour that specifies intentions, that is, an individual's readiness or motivation to engage in a behaviour or not, are the most proximal predictor of behaviour. An individual's intentions are predicted by their attitude, subjective norm and PBC. PBC is a construct similar to self-efficacy; it refers to one's perception of how much control over their behaviour they have, and this can be influenced by external or internal factors (Ajzen, 1991). In addition to indirectly influencing behaviour via one's intention, PBC can also influence behaviour directly (Sheeran, Trafimov & Armitage, 2003). Attitudes refer to one's overall evaluation of a particular behaviour. Subjective norms are an individual's beliefs about whether their social group and significant others would approve or disapprove of the behaviour. Therefore, to understand why people choose to consume health-promoting food, subjective norms, attitudes, PBC and intentions all need to be examined.

Two recent systematic reviews (McDermott et al., 2015a, 2015b) show that the TPB does have predictive power for dietary behaviour including both discrete food choices and wider dietary patterns. The first review (McDermott., 2015a) examined the associations between TPB variables and dietary patterns (e.g. 'healthy eating' or 'restrictive dietary patterns') and demonstrated that TPB variables had medium to strong correlations with both intention and behaviour. Intention had the strongest correlation with behaviour, followed by PBC. The results showed no moderating effect by type of dietary pattern on behaviour.

The second systematic review (McDermott et al., 2015b) investigated associations between TPB variables and discrete food choices and demonstrated that all TPB variables had medium to strong correlations with intention and behaviour. Of these, intention had the strongest association with behaviour followed by PBC. This review also showed that some TPB variables are more strongly correlated with certain food choices compared to others. Results showed significantly higher PBC and behaviour associations for choosing unhealthy foods compared to choosing healthy foods. McDermott et al. suggest that this may be due to people having distorted perceptions of their control over choosing healthy foods. Furthermore, significantly higher associations between intention and behaviour, and PBC and behaviour were found for choosing healthy foods compared to avoiding unhealthy foods. These findings highlight the multifaceted nature of diet choices and the factors underpinning these behaviours, and suggest there may be other moderating factors involved beyond those outlined in the TPB.

TPB: Moderated by SES

Examining whether the relationships between TPB variables and health promoting dietary behaviour differ depending on SES may help to explain why diet related inequalities exist between different SES groups. Thus far, the evidence is mixed regarding the moderating effect of SES on the associations between TPB variables and health behaviours.

A study conducted by Conner et al. (2013) tested whether SES moderates relationships between health cognitions and health behaviours. Although the study did not specifically examine dietary behaviours, it showed distinct moderator effects suggesting higher intention-behaviour relations in individuals with higher SES. The health behaviours under investigation were smoking initiation, breastfeeding and physical activity. Conner et al. concluded that the intention-behaviour gap is attenuated in low SES samples. The authors explained that individuals from lower SES backgrounds have less access to resources and therefore might find it more difficult to translate their intentions into health behaviours, and this may explain why they typically experience poorer health outcomes than those from higher SES backgrounds.

Other research, however, has failed to replicate these findings. Godin, Amireault et al. (2010) found no significant moderation effect of SES on intention to eat more fruit and vegetables. Furthermore, Vasiljevic et al. (2016) investigated whether the intention-behaviour gap varies by SES for different health behaviours (physical activity, low-fat diet, smoking cessation and medication adherence) and found no evidence for a socioeconomic patterning of the intention-behaviour gap. However, a larger gap between self-efficacy (a construct similar to PBC) and health behaviours in those from lower SES backgrounds compared to those from high SES backgrounds was found (Vasiljevic et al., 2016).

The evidence is clearly limited and inconsistent regarding the extent to which SES affects the direction and/or strength between health cognitions and health behaviours. Due to the variability in findings there is no compelling evidence for a socioeconomic patterning of the relationship between health cognitions and health behaviour. It remains unclear if any indicators of SES underlie a moderating effect of SES on the relationship between TPB variables and behaviours. In particular, it is yet to be established if and how SES affects the regulation of individual dietary behaviour. By pooling the available evidence from a large number of studies investigating TPB variables and diet, with potentially diverse SES samples, this issue can be better investigated with more robust tests. As the TPB has been so widely studied in relation to dietary behaviours, the theory provides a substantial database of studies to be reviewed that are likely to have measured health cognitions in a similar way.

Research Questions

The current study aims to systematically review the existing literature on the relationships between health promoting dietary behaviours and the social-cognitive predictors in the TPB (attitudes, subjective norm, PBC and intention). If significant heterogeneity between studies is observed in these associations, the current study will also investigate whether different individual-level indicators of SES can explain this hypothesised heterogeneity between TPB constructs and health promoting dietary behaviour. By investigating whether SES related differences in the self-regulation of individuals' dietary behaviour exist, SES inequalities in diet may be further understood.

Method

A systematic review with meta-analysis was conducted. Both the conduct and reporting of the study is in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (PRISMA) (Moher et al., & The PRIMSA Group, 2009). Ethics approval was not required as the current study involved secondary analysis of existing data.

Literature Search and Search Strategy

Four electronic databases, *Web of Science*, *Scopus*, *Medline* and *CINAHL* were searched using the following search strings (1) "theory of reasoned action" OR "theory of planned behavio*" OR Ajzen; (2) "perceived behavio* control" OR "subjective norm*" OR attitude* AND intention*; (3) eat* OR diet* OR consumption OR food OR fruit* OR vegetable* OR fat OR fibre OR fiber OR carb* OR sugar OR snack OR protein* OR superfood* OR wholefood*. The reference lists from McDermott et al. (2015a) and McDermott et al.'s (2015b) meta-analyses were also searched manually. The initial searches yielded 6745 records in total. 1771 records were identified from Medline, 1863 from Web of Science, 2445 from Scopus and 666 from CINAHL. After removing 2743 duplicates 4002 records remained available for review.

Eligibility Criteria

To be eligible for inclusion in the current review, studies published in English had to meet the following inclusion criteria: (1) include a quantitative measure of individual health promoting dietary behaviour (defined as dietary behaviour that impacts or has the potential to impact one's health in a positive way (e.g. reduction in risk of heart disease). Both discrete dietary choices (e.g. eating fruit) and dietary styles (e.g. I eat a healthy diet) were included. Both self-reports and objective measures were included; (2) the behaviour had to involve consuming health-promoting food and not avoiding unhealthy food; (3) report at least one correlation between the TPB constructs (intention, PBC, subjective norm and attitude) and dietary behaviour; (4) examine an adult population and; (5) provide an indicator of the SES of the sample (educational attainment, any income indicator, occupational status or race). If a study met all inclusion criteria except providing zero-order correlations and/or SES data, the authors were emailed to request data and received up to two reminders.

Studies were excluded if they met any of the following criteria: (1) intellectually disabled sample or sample with eating disorders (as the psychological predictors of dietary choices in such populations may not be representative of the wider community); (2) previous meta-analysis or systematic review; (3) qualitative design; (4) reported data provided in another included study; (5) intervention studies (unless they provided baseline correlation data); (6) consumption of dietary supplements, soft-drink, milk, alcohol or any other beverage; (7) food provision (e.g., parents preparing food for their children); (8) SES information could not be coded in a manner that allows comparisons between groups (i.e. Lampert system) and; (9) if no correlation data or SES information could be obtained upon emailing authors.

Literature Selection

Firstly, two independent coders GF and SLW scanned the 4002 titles and abstracts for inclusion in the study. 3659 were removed and the full texts of the remaining 343 articles were retrieved. Differences were resolved by discussion amongst BS, GF and SLW. The inclusion and exclusion criteria were then applied to the full text articles and a further 294 studies were excluded. Following these steps 51 articles (65 studies) met all inclusion criteria and were included in the meta-analysis. A flow chart for study selection is in figure 1.

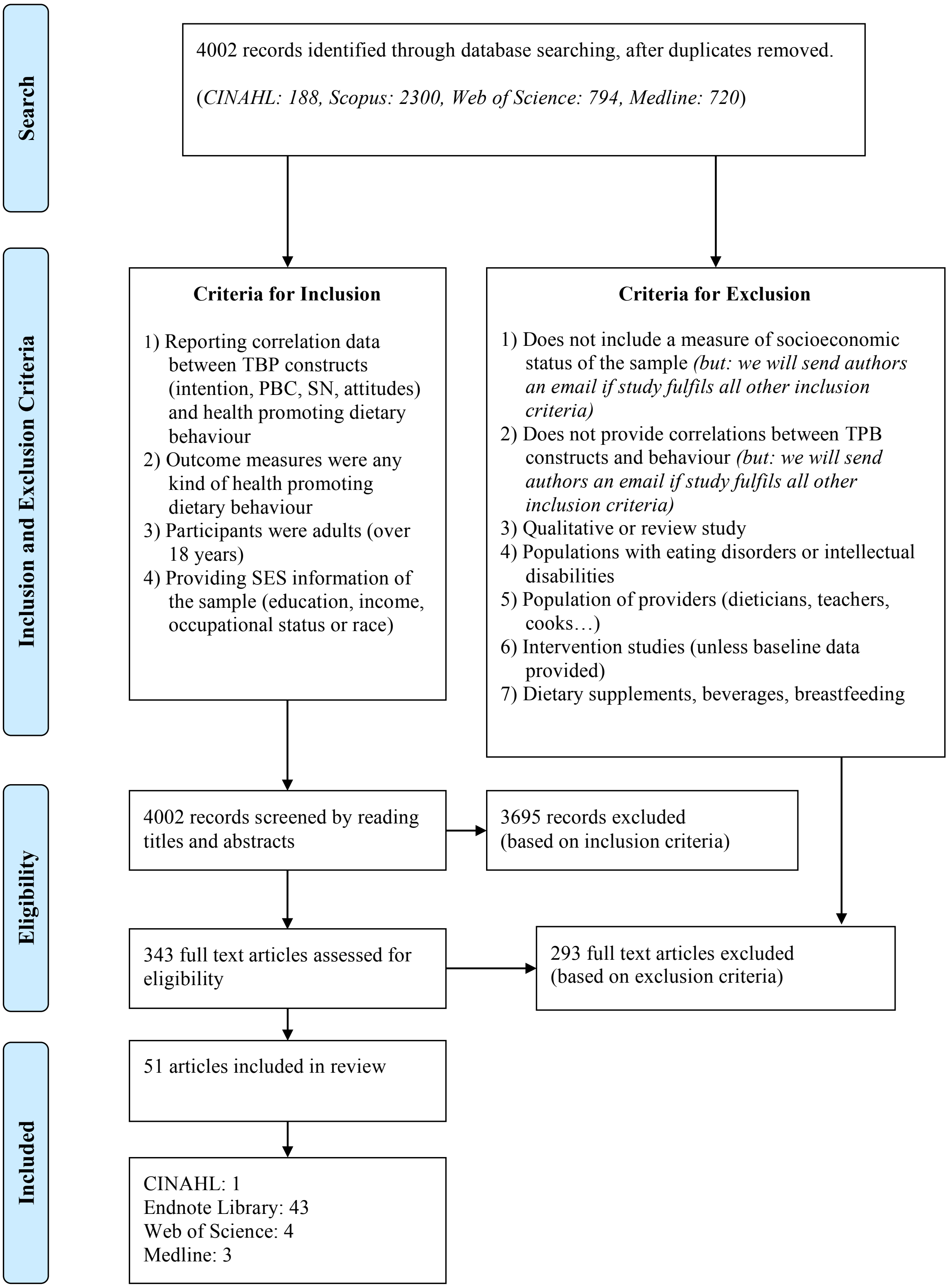

Figure 1. PRISMA flow chart

Data Collection and Coding

Study-level variables such as year of publication, number of studies in the article, country of origin, age, sex composition and SES information of the sample, number of dependent variables, behaviour type (e.g. discrete vs. dietary style) means, standard deviations, reliability coefficients, inter-correlations between the TPB variables and dietary behaviour and the sample size of these correlations were collected in an electronic database (Limesurvey). If a study provided two separate correlations for one TPB construct (e.g. instrumental and affective attitudes), the correlations were averaged using Fisher's r-to-z transformation. Indicators of study level risk of bias were also recorded: type of sample, type of assessment and study design. The coders conducted the coding independently to reduce errors and subjective judgements. A random subset of 20 correlations was cross-coded to examine inter-rater reliability (proportion of concordance = .09, 95% CI = [0.67, .98]), calculated according to the Wilson efficient-score method (Lowry, 2016). Differences were resolved by discussion amongst BS, GF and SLW.

Coding of SES Information

SES information relating to educational attainment and income was extracted and then transformed into a point score using a system developed by the German Federal Robert Koch Institute (Lampert et al., 2013, see Appendix A). This transformation allowed SES information to be comparable both between and within categories in a standardised way. The scores for education and income in this system ranged from 1-7 and had been developed based on their predictive value for income categories. Studies were coded based on the information available for the majority of the sample. For example, if a study reported 58% "undergraduate students" the study was coded "university students." The classification and categorisation of educational attainment in this system is based on the international classification the Comparative Analyses of Social Mobility in Industrialized Nations (CASMIN). Each of the categories was allocated a point score (e.g., a sample with a majority of university PhD graduates would be coded as 7 points). To code the income information, the mean income of the study sample was transformed into a percentile rank based on archival national income distributions for that year. For example, if a study was conducted in Finland in 2005, the percentile rank was calculated by comparing the average study sample income to the average Finnish household income distribution in 2005. Then, the percentiles were coded according to the Lampert et al. scoring system. Because the indicators in the Lampert coding system are based on a somewhat arbitrary criterion and have been criticised for lacking equivalence across countries (e.g. Schneider, 2010), education and income were additionally coded into high vs. low based on the median of the overall distribution of study samples. Independent of the Lampert et al. system (2013) occupation was dichotomized into blue or white-collar workers and also employed or unemployed based on the majority of the sample. For example, if a study reported 72% manual and 28% non-manual the study was coded as blue collar and employed. Sample race was coded as majority or minority racial group based on the majority of the sample. For example, if a study was conducted in Australia and reported 75% Caucasian Australian and 25% Asian the sample would be coded as majority racial group.

Meta-Analytic Strategy

Three steps were involved in the meta-analytic strategy. Firstly, the effect sizes (zero-order correlations) were transformed into a common metric using Fisher's z-transformation. Secondly, a random effects meta-analysis was conducted on the z-transformed correlation coefficients between TPB variables and health promoting dietary behaviour to determine overall effect sizes and an estimate of heterogeneity between studies. The reason for conducting a random-effects meta-analysis is that in reality the true effect size in the underlying population is likely to differ due to study heterogeneity. In order to investigate this heterogeneity between studies, Cochran's Q and I^2 statistics were examined. When a Q value is significant it indicates significant heterogeneity in the effect sizes (Q follows a Chi-squared distribution) (Borenstein et al., 2010). The I^2 statistic indicates whether the percentage of variability in the effect sizes (correlations) is caused by true differences opposed to chance. Values of 25% indicate low heterogeneity, 50% indicate moderate heterogeneity and 75% indicate high heterogeneity (Higgins et al., 2003). R was used to perform all analyses, using the metafor package (Viechtbauer, 2010).

Analysis of Subgroups or Subsets

The third step in the meta-analysis was to conduct meta-regressions in the random effects meta-analytic model to estimate the effects of study-level SES indicators (education, income, race, or occupation) on the pooled relationships between each TPB variable and health promoting dietary behaviour to predict the intercepts of the correlation coefficients.

Risk of Bias (Quality) Assessment

If the studies included in a meta-analysis are of poor quality then the conclusions drawn are likely to be over or underestimated (Card, 2011). Therefore, when conducting a meta-analysis, it is vital to assess the risk of bias in the outcomes across studies in order to assess the quality of the evidence and correctly interpret results and draw conclusions (Higgins et al., 2011). To assess risk of bias in the current meta-analysis certain study characteristics were examined. The first characteristic assessed was sample selectivity. A homogeneous sample indicates high risk of bias, a heterogeneous sample indicates a medium risk of bias and a representative sample for the population indicates a low risk of bias (Thompson et al., 2011). For example, a study sample comprised of university students would be coded as homogenous as this sample is not representative of the wider community, indicating a high risk of bias. The second characteristic assessed was study design (longitudinal vs. cross-sectional). Studies over 8 weeks indicate low risk of bias, studies between 1 and 7 weeks indicate medium risk of bias and cross-sectional studies indicate high risk of bias (Weinstein, 2007). The third characteristic assessed was the method of measuring dietary behaviour. Objective measures indicate low risk of bias, validated self-reports indicate a medium risk of bias, and non-validated self-reports indicate a high risk of bias (Higgins et al., 2011).

Finally, funnel plots were examined in order to check for bias due to sample size. If a funnel plot is significantly asymmetrical this indicates a relationship between sample size and effect size (in particular overly large effect sizes in smaller studies) and results must be interpreted with caution (Card, 2011).

Results

Study Characteristics

Fifty-one articles (k = 65 studies) provided all relevant information and were therefore included in the meta-analysis. Sixty-four studies used self-report measures of health promoting dietary behaviour and one study used an objective measure (observation during a food choice paradigm). In terms of behavioural measure, the most common method was frequency measures e.g. Food Frequency Questionnaire (n=60), three studies examined following guidelines and two examined nutritional style. The sample sizes of the included studies ranged from 59 (Chevance et al., 2016) to 2031 (Wilson et al., 2016). The included studies were published between

2000 and 2016. The studies originated from 15 different countries with the U.S.A. (18%), U.K. (16%) and Australia (15%) being most represented. Regarding the SES indicators, 49 studies (74%) provided education information, 9 studies (14%) provided income information, 19 studies (29%) provided information regarding employment status, 10 studies (15%) provided occupational status information (blue vs. white collar), and 42 (64%) studies provided information regarding the race of the sample. Regarding education, 35 of the 65 studies involved undergraduate student samples, skewing the overall distribution of educational attainment towards better-educated and younger samples. Regarding income, 6 of the 9 study samples had an income above the income median of their countries in the year the study was conducted, meaning generally more affluent samples were included. In terms of occupation, 14 out of the 19 samples were employed. Of those that provided occupational status information 5 were blue-collar employees and 5 white were white-collar employees. Regarding the race of the samples, 32 out of 42 were in the majority ethnic group. For more study characteristics see Appendix D.

Regarding risk of bias from assessment only one study used an objective measure of health promoting dietary behaviour, 23 studies (35%) used non-validated self-report measures and the remaining 41 studies (63%) used validated self-report measures. This suggests an overall medium risk of bias from low-quality measurement of the outcome variable. Regarding risk of bias from sample selectivity 39 studies (60%) included homogenous samples, 19 studies (29%) included community samples and 7 studies (11%) included representative samples, suggesting an overall high risk of bias from low-quality samples. Regarding risk of bias from design, 11 studies (17%) 8 weeks or more, 13 studies (20%) were 1-8 weeks and 41 studies (63%) were cross-sectional studies, suggesting an overall high risk of bias due to poor design. For risk of bias assessment graph see Appendix B.

TPB Variables and Health Promoting Dietary Behaviour

The first step in the meta-analysis was to examine the associations between attitudes, intentions, PBC, subjective norm and health promoting dietary behaviour (HPDB). Table 1 shows that all TPB variables were significantly and positively associated with HPDB. Intention had the strongest correlation with behaviour, consistent with TPB assumptions. Fisher's z-transformed correlation between intention and HPDB was 0.46, 95% CI = [0.39, 0.53], p <.001, indicating that intention explained 21% of the variance in HPDB, 95% CI = [15.21%, 28.09%]. Fisher's z-transformed correlation between PBC and HPDB was 0.33, 95% CI = [.27,.39] p <.001, indicating that PBC explained 11% of the variance in HPDB, 95% CI = [7.29%, 15.21%]. Fisher's z-transformed correlation between attitude and HPDB was 0.27, 95% CI = [0.21, 0.34] p <.001, indicating that attitude explained 7% of the variance in HPDB, 95% CI = [4.41%, 11.56%]. Subjective norm had the weakest association with HPDB. Fisher's z-transformed correlation between subjective norm and HPDB was 0.15, 95% CI = [0.09, 0.20] p <.001, indicating that intention explained 2.25% of the variance in HPDB, 95% CI = [0.81%, 4.0%]. The associations between intention-behaviour and PBC-behaviour have medium effect sizes and the associations between attitude-behaviour and subjective norm-behaviour have small size effects according to Cohen (1992). All funnel plots for asymmetry were not significant. The largest z = 1.12 for the association between subjective norm and behaviour, indicating no risk of bias due to small sample size and trim-and-fill analyses are not required. Forest plots are in Appendix E and Funnel plots are in Appendix F.

The Q statistic for all four associations was significant, showing significant heterogeneity between studies. This suggests that the effect sizes varied significantly between studies and that moderating variables such as SES may account for this variation. The I^2 statistic for each association was above 75%, therefore, suggesting high heterogeneity between the TPB variables and behaviour according to Higgins et al. (2003).

Table 1.

Fisher's z Transformed Correlation and Heterogeneity Statistics for TPB Associations with Health Promoting Dietary Behaviour

	Health Promoting Dietary Behaviour					
	k	*N*	r_z (SE)	(95% CI)	Q	I^2
Intention	58	18521	0.46(0.04)	(.39, .53)	1348.72***	95.56%
Attitude	48	13430	0.27(0.03)	(.21, .34)	616.02***	92.63%
Subjective Norm	45	12395	0.15(0.03)	(.10, .22)	448.95***	89.36%
PBC	47	12742	0.33(0.03)	(.27, .39)	456.43***	90.44%

Note. PBC - perceived behavioural control. *K* = number of studies; r_z – Fisher's z transformed correlation coefficient, *** p<.001

Moderator Analyses: Meta-Regressions with SES

The next step was to conduct meta-regressions with the four different SES indicators (education, occupation, income and race) as study-level predictors of the Fisher's z-transformed correlation coefficients obtained from the random-effects meta-analysis.

Education

Study level effect sizes (z-transformed correlations between intentions, PBC, attitude and subjective norm) were regressed on the education of the samples in the studies (*k* = 49). These studies had a mean education score of 4.65 (*SD* = .94) following Lampert et al.'s coding system. Table 2 shows that education did not significantly predict the size of the correlation between TPB variables and health promoting dietary behaviour. Furthermore, the non-significant Q_M statistic demonstrates that education did not reduce the heterogeneity between studies. The R^2 value of zero indicates that education did not explain any of the variance in relations between intention, PBC or subjective norm and health promoting dietary behaviour, although it did explain 3.86% of variance in relations between attitude and behaviour.

The moderator effect of education was further investigated by regressing the study-level correlations on an indicator of high vs. low educational attainment based on the median split of the education distribution. This indicator is independent of the Lampert et al. (2013) system. The results of this second test were almost identical; there was no significant moderator effect of education, and education did not reduce heterogeneity between studies, see Table 2. The R^2 value of zero indicates that education did not explain any of the variance in relations between intention, PBC or subjective norm and health promoting dietary behaviour, although it did explain 4.89% of variance in relations between attitude and behaviour. Forest plots are displayed in Appendix E.

Occupation

Study level effect sizes (z-transformed correlations between intentions, PBC, attitude and subjective norm) were regressed on the employment status (unemployed or employed) of the samples in the studies (k=19). Table 2 shows that this indicator of occupation did not significantly predict the size of the correlation between TPB variables and health promoting dietary behaviour. Furthermore, the non-significant Q_M statistic demonstrates that employment status did not reduce the heterogeneity between studies. The R^2 value of zero indicates that employment status did not explain any of the variance in relations between intention, PBC or subjective norm and health promoting dietary behaviour, although it did explain 0.14% of variance in relations between attitude and behaviour.

The moderator effect of occupation was further investigated by regressing the study-level correlations on a different measure of occupation status (blue or white collar employee) (k = 10). The results of this second test were almost identical; there was no significant moderator effect of occupational status; it did not reduce heterogeneity between studies, see Table 2. The R^2 value of zero indicates that occupational status did not explain any of the variance in relations between any TPB variables and health promoting dietary behaviour. Forest plots are displayed in Appendix E.

Income

Study level effect sizes (z-transformed correlations between intentions, PBC, attitude and subjective norm) were regressed on the income of the samples in the studies (k=9). These studies had a mean education score of 4.39 (SD = 1.75) following Lampert et al.'s coding system. Table 2 shows that income did not significantly predict the size of the correlation between TPB variables and health promoting dietary behaviour. Furthermore, the non-significant Q_M statistic demonstrates that income did not reduce the heterogeneity between studies. The R^2 value of zero indicates that income did not explain any of the variance in relations between intention or PBC and health promoting dietary behaviour, although it did explain 9.90% of variance in relations between attitude and behaviour and 2.92% of variance in relations between subjective norm and behaviour.

The moderator effect of income was further investigated by regressing the study-level correlations on an indicator of high vs. low income based on the median split of the income distribution. This indictor is independent of the Lampert et al. (2013) system. The results of this second test again demonstrated no significant moderator effect of income, and income did not reduce heterogeneity between studies, see Table 2. The R^2 value of zero indicates that income did not explain any of the variance in relations between PBC and health promoting dietary behaviour, although it did explain 14.42% of variance in relations between intention and behaviour, 9.72% between attitude and behaviour, and 49.02% between subjective norm and behaviour. Forest plots are displayed in Appendix E.

Race

Study level effect sizes (z-transformed correlations between intentions, PBC, attitude and subjective norm) were regressed on the race, majority or minority ethnic group of the samples in the studies (k=42). Table 2 shows that race did not significantly predict the size of the correlation between TPB variables and health promoting dietary behaviour. Furthermore, the non-significant Q_M statistic demonstrates that race did not reduce the heterogeneity between studies. The R^2 value of zero indicates that education did not explain any of the variance in relations between TPB variables and health promoting dietary behaviour. Forest plots are displayed in Appendix E.

For the majority of moderation analyses, tests for funnel plots asymmetry were not significant, indicating no disproportional influence of small sample sizes and no need for trim-and-fill analyses. However, the tests for funnel plots asymmetry for subjective norm-behaviour (moderated by income), attitude-behaviour (moderated by occupational status), PBC-behaviour (moderated by occupational status) and PBC-behaviour (moderated by employment status) were significant.

Therefore, these relations need to be interpreted with caution. Funnel plots are displayed in Appendix F.

Table 2.
Mixed Model Meta-Regression of Effect Sizes on SES Indicators

r_z (TPB variable-behaviour)	*k*	*N*	Intercept	*B* (SE)	95% CI	*p*	Q_E (df)	Q_{Mr} (df)	I^2	R^2
				Income						
Intention – behaviour	9	3,952	0.80	-0.09 (0.14)	-0.44, 0.25	0.54	784.13 (7)***	0.42 (1)	98.90%	0.00%
PBC – behaviour	8	3,542	0.12	0.03 (0.11)	-0.25, 0.30	0.83	95.43 (6)***	0.06 (1)	94.85%	0.00%
Attitude – behaviour	8	3,542	0.91	-0.14 (0.11)	-0.40, 0.12	0.23	116.61 (6)***	1.74 (1)	94.51%	9.90%
Subjective norm– behaviour	7	3,362	0.78	-0.14 (0.13)	-0.48, 0.19	0.33	123.55 (5)***	1.16 (1)	96.52%	2.92%
				Income High vs. Low						
Intention – behaviour	9	3,952	1.14	-0.45 (0.29)	-1.14, 0.24	0.17	645.77 (7)***	2.34 (1)	98.54%	14.42%
PBC – behaviour	8	3,542	0.05	0.11 (0.17)	-0.32, 0.55	0.55	100.18 (6)***	0.39 (1)	94.39%	0.00%
Attitude – behaviour	8	3,542	0.64	-0.22 (0.17)	-0.66, 0.20	0.24	123.91 (6)***	1.71 (1)	94.31%	9.72%
Subjective norm– behaviour	7	3,362	0.80	-0.40 (0.16)	-0.81, 0.00	0.05	68.57 (5) ***	6.4 (1)	93.35%	49.02%

Occupation Blue vs. White										
Intention – behaviour	9	2,987	0.22	0.13 (0.18)	-0.30, 0.55	0.51	103.33 (7)***	0.49 (1)	94.74%	0.00%
PBC – behaviour	7	1,278	0.08	0.12 (0.18)	-0.34, 0.57	0.54	42.06 (5)***	0.44 (1)	86.45%	0.00%
Attitude – behaviour	7	1,694	0.34	-0.02 (0.16)	-0.44, 0.40	0.91	48.56 (5)***	0.02 (1)	86.96%	0.00%
Subjective norm– behaviour	6	992	-0.01	0.05 (0.20)	-0.50, 0.62	0.79	41.90 (4)***	0.07 (1)	87.52%	0.00%
Occupation Employed vs. Unemployed										
Intention – behaviour	15	6,360	0.39	0.03 (0.12)	-0.24, 0.29	0.83	149.43 (13)***	0.05 (1)	93.78%	0.00%
PBC – behaviour	12	2,620	0.26	0.04 (0.09)	-0.16, 0.25	0.62	49.61 (10)***	0.26 (1)	78.79%	0.00%
Attitude – behaviour	12	3,036	0.21	0.09 (0.11)	-0.15, 0.34	0.41	73.58 (10)***	0.73 (1)	86.41%	0.14%
Subjective norm –behaviour	11	2,334	0.11	-0.04 (0.09)	-0.26, 0.19	0.73	56.48 (9)***	0.13 (1)	80.29%	0.00%

				Education						
Intention – behaviour	43	12,696	0.43	0.01 (0.07)	-0.13, 0.14	0.88	1121.46 (41)***	0.02 (1)	95.43%	0.00%
PBC – behaviour	35	10,657	0.42	-0.01 (0.05)	-0.11, 0.09	0.81	340.96 (33)***	0.05 (1)	90.98%	0.00%
Attitude – behaviour	37	11,631	0.68	-0.08 (0.06)	-0.20, 0.03	0.16	471.87 (35)***	2.10 (1)	93.61%	3.86%
Subjective norm– behaviour	34	10,596	0.37	-0.04 (0.05)	-0.15, 0.06	0.41	385.11 (32)***	0.71 (1)	90.68%	0.00%
				Education High vs. Low						
Intention – behaviour	43	12,696	0.54	-0.04 (0.10)	-0.26, 0.17	0.67	1118.11 (41)***	0.18 (1)	95.50%	0.00%
PBC – behaviour	35	10,657	0.37	-0.00 (0.08)	-0.16, 0.16	0.99	344.97 (33)***	0.00 (1)	91.18%	0.00%
Attitude – behaviour	37	11,631	0.12	0.13 (0.09)	-0.04, 0.32	0.13	462.75 (35)***	2.43 (1)	93.66%	4.89%
Subjective norm– behaviour	34	10,596	0.11	0.05 (0.07)	-0.11, 0.21	0.54	385.59 (32)***	0.38 (1)	90.97%	0.00%

Race Majority vs. Minority										
Intention – behaviour	37	13,794	0.34	0.11 (0.12)	-0.13, 0.36	0.36	1068.28 (35)***	0.86 (1)	96.62%	0.00%
PBC – behaviour	29	8,684	0.27	0.03 (0.11)	-0.19, 0.25	0.79	291.44 (27)***	0.07 (1)	92.34%	0.00%
Attitude – behaviour	30	8,924	0.19	0.06 (0.11)	-0.16, 0.29	0.57	428.63 (28)***	0.32 (1)	93.86%	0.00%
Subjective norm– behaviour	30	8,922	0.17	-0.03 (0.09)	-0.22, 0.15	0.72	365.70 (28)***	0.13 (1)	91.37%	0.00%

Note. *** $p < .001$; PBC – Perceived Behavioural Control. $Q_E = Q$ statistic for residual between-studies variance, $Q_M = Q$ statistic for the moderator.

Discussion

This systematic review and meta-analysis investigated whether SES moderated the associations between social-cognitive predictors in the TPB (Ajzen, 1991) and health promoting dietary behaviour. Results showed that none of the SES indicators were significant moderators of the relationships between any TPB variables and health promoting dietary behaviour.

The vast majority (56 out of the 58 studies reviewed) reported positive correlations between intention and HPDB. The average correlation between intention and behaviour was .46, suggesting that one's intention to engage in HPDB can explain 21% of the variance in such behaviour. Regarding PBC, 45 out of the 47 studies reviewed reported positive correlations between PBC and HPDB. The average correlation between PBC and behaviour was .33, suggesting that one's PBC towards HPDB can explain 11% of the variance in such behaviour. For attitude, 45 out of the 48 studies reviewed reported positive correlations between attitude and HPDB. The average correlation between attitude and behaviour was .27, suggesting that one's attitude towards HPDB can explain 7% of the variance in such behaviour. Finally, with regards to subjective norm, 37 out of the 45 studies reviewed reported positive correlations between subjective norm and HPDB. The average correlation between subjective norm and behaviour was .16, suggesting that one's subject norm regarding HPDB can explain 2% of the variance in such behaviour. These results are consistent with other systematic reviews which have supported the predictive validity of the TPB for dietary behaviour (e.g. McDermott et al., 2015a; 2015b).

As indicated by the significant Q values and I^2 percentages above 75% there was significant heterogeneity between studies for the relations between TPB variables and health promoting dietary behaviour. These results support the hypothesis that significant heterogeneity would be detected between studies and therefore, the moderation analyses were justified.

The SES of the of 65 study samples was coded based on a four-facet model of SES. Education and income were analysed using the 7-point coding system developed by Lampert et al. (2013). Income and occupation were further investigated based on the median split (high vs. low). Two measures of occupation were examined: occupational status (blue or white collar employees) and employment status (employed or unemployed). Race was dichotomised into majority or minority racial group in the country of origin.

Education as a Moderator of TPB

Education did not moderate the relationships between any of the TPB variables and health promoting dietary behaviour. Neither the continuous indicator (Lampert et al., 2013) nor the dichotomous indicator (high vs. low) moderated the associations between TPB variables and health promoting dietary behaviour. However, the R^2 value indicates that the continuous education indicator did explain 3.86% of variance in relations between attitude and behaviour and the dichotomous indicator explains 4.89% of variance in relations between attitude and behaviour. These results suggest that as education increases, the correlation between attitude and behaviour decreases. However, for the dichotomous indictor, those with higher education had higher correlations between attitudes and behaviour. The fact that these effects are small and inconsistent in their direction suggests that these could be an artefact of how the dichotomous indicator was generated rather than an accurate reflection of how education might affect the attitude-behaviour relationship.

The results of the current study are consistent with Godin, Amireault et al. (2010) who found no significant moderation effect of education on intention to eat more fruit and vegetables. These findings are also consistent with studies that found no moderation effect of education on the relationships between TPB variables and physical activity (e.g. Schüz et al., 2012, Vasiljevic et al., 2016).

The fact that the current findings differ from those reported in Godin, Sheeran et al. (2010) and from those reported by Conner et al. (2013) could be due to the fact that the current study examined a different health behaviour to Conner at al. (2013) (breastfeeding and physical activity) and Godin, Sheeran et al. (2010) (physical activity). As well as measuring different health behaviours, the way SES was operationalised and measured also differed between studies. In the Conner et al. study SES was measured by postcode as an indicator of household deprivation for the breastfeeding study and by occupation for the physical activity study. Therefore, the role of education as an individual-level measure of SES was not assessed in their study. These inconsistencies suggest that the way SES is operationalised and measured may influence results.

It is also possible that in the current study the effect of education was masked by assessing the education level of the whole study sample, instead of individual educational attainment. Furthermore, even though education may provide one with the necessary nutrition knowledge, healthy diet choices may not be achieved. For example, cooking and food preparation skills have been shown to enable individuals to make healthier food choices (Hartmann, Dohle, & Siegrist, 2013) and high education does not necessarily equate to cooking skills. Alternatively, it may not be educational attainment but rather one's interest in nutrition knowledge or degree of such knowledge instead that influences the relationships between TPB variables and health promoting dietary behaviour.

It is also worth noting that undergraduate students made up a vast proportion of participants in the included studies. Research indicates that university students often have poor dietary habits and fail to meet recommended daily fruit and vegetable intakes (Silliman, Rodas-Fortier & Neyman, 2004). Furthermore, university students are typically young adults and more likely to live at home, therefore they may not be fully in control of what they eat. Due to these factors the psychological determinants of eating behaviour and the role education has on the relationship with TPB variables and diet for undergraduate students may not be generalisable to the wider community.

Income as a Moderator of TPB

Neither the continuous indicator (Lampert et al., 2013) nor the dichotomous indicator (high vs. low) significantly moderated the relationships between any of the TPB variables and health promoting dietary behaviour. This finding is consistent with Godin, Amireault et al. (2010) who found no significant moderation effect of income on intention to eat more fruit and vegetables, and Godin, Sheeran et al. (2010) who found no significant moderation effect of income on intention to be more physically active.

Although no significant moderation effect was found, income did explain 9.90% of variance in relations between attitude and behaviour and 2.92% of variance in relations between subjective norm and behaviour. These results suggest that as income increases the correlation between attitude and behaviour and subjective norm and behaviour decreases. However, these effects were small and non-significant and could be artefacts from the small number of studies examining attitude-behaviour and subjective norm-behaviour relationships.

For the dichotomous indicator income explained 49.02% of variance in the correlations between subjective norm and behaviour, 14.42% of variance in relations between intention and behaviour, and 9.72% of variance in relations between attitude and behaviour. These results suggest that those with higher income had lower correlations between subjective norm and behaviour, intention and behaviour and attitude and behaviour. However, these effects were non-significant and the number of included studies was very small, casting further doubt over these effects. It is worth noting that the p value for the moderation effect of income (high vs. low) on the relationship between subjective norm and behaviour, was close to reaching significance, $p = 0.0521$. Upon visual inspection of the funnel plot for this effect, one study falls outside the funnel, suggesting this study may have undue influence on the results, and therefore, explain why income appears to account for 49% of variance in the relations between subjective norm and behaviour.

One potential reason that no significant moderation effect was found is that assessing household income (and on a study level basis) instead of individual income may have masked the effects of income on the relations between TPB variables and behaviour. Furthermore, for the income moderation analyses k = 7-9, however it has been suggested that adequate power can only be assumed when meta-regressions include more than 40 studies (López-López, et al., 2014). Only including a small number of studies may have biased the results.

Occupation as a Moderator of TPB

Occupation also did not moderate the relationships between any of the TPB variables and health promoting dietary behaviour. Neither the dichotomous employment status indicator nor the dichotomous occupational status indicator moderated the association between TPB variables and health promoting dietary behaviour. These findings are consistent with Godin, Amireault et al.'s (2010) study that found no significant moderation effect of SES on intention to eat more fruit and vegetables. However, it is important to note that Godin, Amireault et al.'s (2010) measured SES by education, income and material deprivation and not actual occupation. This result differs from Conner et al. (2013) who found that occupation moderates the relationship between intention and physical activity. One possible reason for the inconsistencies is that different health behaviours were examined between Conner et al. (2013), and the current study. Again, measuring occupation on a study level basis may have masked individual effects.

Race as a Moderator of TPB

Finally, race was not a significant moderator of the relationships between any of the TPB variables and health promoting dietary behaviour. This result is consistent with Blanchard et al. (2009) who found race did not significantly moderate any TPB variable relationships with fruit and vegetable intake in university students. Therefore, it appears that race may not be an important moderator of the relationships between TPB variables and health promoting behaviour. Instead environmental factors such as where one lives (e.g. supermarket availability differs in different ethnic neighbourhoods) may be a more important determinant of dietary behaviour.

TPB and SES: Mediation Instead of Moderation?

Overall, the results from the moderation analyses provide support for Ajzen's (1985) sufficiency-hypothesis which states all theory-external influences on behaviour operate indirectly through TPB constructs. According to this hypothesis, SES can be understood as an external background factor and the influence of SES on diet is mediated by the social-cognitive constructs in the model (Ajzen, 1985, Conner

& Norman, 2015). If SES exerts its influence on diet by influencing the health cognitions in the model, the TPB variables alone provide a sufficient explanation for health promoting dietary behaviour without considering a direct or moderating effect of SES. Although some researchers have argued that the sufficiency-hypothesis is indefensible and has been falsified (e.g. Sniehotta, Presseau, & Araújo-Soares, 2014), the findings of the current study cast doubt on this conclusive argument. The role of SES on the associations between TPB constructs and health behaviours appears to be more complicated than previously thought and thus cannot be definitively concluded.

Consistent with the TPB assumption that intentions are the key proximal determinant of behaviour, the current review found that intention had the strongest correlation with behaviour. If intentions mediate external influences such as SES, this means if an individual has strong intentions to make healthy dietary choices, their SES does not appear to moderate the intention-behaviour relationship.

Possible Methodological Explanations

There may be other explanations relating to methodology that explain why a moderating effect of SES was not found in this study. Firstly, the type of SES indicators used may have affected the results of moderation analyses. For example, Vasiljevic et al. (2016) only found a significant moderation of the association between health cognitions and behaviour when area-level SES measures were used but not individual-level measures. This suggests that SES may have different effects depending on how it is defined and measured. The current study operationalised SES using four individual-level facets and did not include any area-level SES measures (e.g. neighbourhood and geographic area). This may partly explain why no moderation effect was found, as area-level SES measures have been implicated in health behaviour inequalities between different SES groups.

Area-level SES measures may be more likely to moderate the relationships between TPB variables and diet as food choices often depend on the wider context and environment (e.g. food and supermarket availability). Individual-level SES measures may be more likely to moderate the relationships between TPB variables and health behaviours that are under one's own volition, independent of the wider environment (e.g. brushing teeth) (Vasiljevic et al., 2016). Indeed, evidence does suggest that area-level SES is strongly associated with diet. A study conducted by Shohaimi et al. (2004) showed that residential area deprivation predicts fruit and vegetable intake, independently of individual education and occupation status.

Furthermore, the current study did not examine the role of subjective SES, which has been found to be implicated in health inequalities more strongly than objective measures of SES (Adler et al., 2000). It is clear that SES is a very complex factor that can affect one's health status in many ways and on many different levels. Therefore, more comprehensive and also more consistent SES measures are required to fully investigate if, and how SES moderates the associations between social-cognitive predictors and health promoting dietary behaviours.

In addition to SES measurement issues, sample characteristics may also partly explain the inconsistent effects between the current study and previous research. The samples in the present study were largely homogenous with undergraduate students making up the majority. As previously stated, undergraduate students typically have poor dietary behaviour (Silliman, Rodas-Fortier, & Neyman, 2004; Tanton et al., 2015) and consequently, their dietary behaviour may not be representative of the wider population. Additionally, having largely homogenous samples in the meta-analysis (e.g. majority high income earners, highly educated, majority employed and from the majority racial group) is problematic for investigating the moderating role of SES on the relations between TPB variables and health promoting dietary behaviour.

Another element adding to differences in sample characteristics is cultural context. In the present study, the samples originated from 15 different countries. It is likely that cultural context influences the moderating effect of SES on the relationships between TPB variables and diet, as cross-cultural research shows different countries have different attitudes towards food (Rodríguez-Arauz, Ramírez-Esparza, & Smith-Castro, 2016) and different cultural norms regarding eating behaviours (Romeike et al., 2016).

Furthermore, how dietary behaviour was measured (e.g. objectively measured vs. self-report) may have influenced the current results. All but one study used self-report measures of eating behaviour which created challenges in terms of validity and recall and social desirability biases. Food frequency questionnaires (FFQs) were the most commonly used method; however, 35% were non-validated FFQs, thus casting further doubt over the validity of the behavioural measures used. Furthermore, the majority (63%) of studies were cross sectional designs, which carry the highest risk of bias in interpreting data. This is because it is impossible to rule out reciprocal relationships. For example, measuring attitudes at the same time as eating behaviour (self-report) may inflate or deflate actual relationships and not reflect true behaviour (Weinstein, 2007). In addition, although every effort was made to contact study authors to gather all correlations, unfortunately not all attempts were successful, and consequently this may have led to a biased sample.

As previously stated, the effect SES has on the relationships between health cognitions and behaviour may differ depending on the particular behaviour under investigation. Research suggests that different kinds of dietary behaviour have different associations with TPB variables (McDermott et al., 2015b). It is likely that different kinds of health promoting dietary behaviour also have different relationships with TPB variables. If what predicts fruit consumption differs from what predicts adhering to a low-fat diet, the effect SES has on these relationships may also differ. This study deliberately focused on a broad range of dietary behaviours although if analyses had been limited to only one type of dietary choice e.g. (only include studies examining fruit), the results may have been different.

On the whole, the current study may have been affected by inadequate sample sizes for the moderation analyses. It has been suggested that adequate power can only be assumed when meta-regressions include more than 40 studies (López-López, et al., 2014). In the current study, income, race and occupation analyses all had less than 40 studies. The sample size for the education moderation analyses was better (*k*=34-43) but still not ideal. In conclusion, this study was limited by the studies on which it was based.

Strengths

Despite the aforementioned study limitations, this systematic review with meta-analysis has some notable strengths. Firstly, this study provided the first systematic review on the role of SES health promoting dietary behaviour within the TPB framework and an updated review about the intention-behaviour relationship relating to health promoting dietary behaviour. This study also included more studies than two recent systematic reviews on TPB and diet (McDermott et al., 2015a; 2015b). Another strength is that the search terms used in this study identified the same studies consistent with previous reviews (e.g. McDermott et al., 2015a; 2015b). Finally, although the coding system used in the study has limitations, this was the only system available at the time of writing that allowed SES to be operationalised in a standardised way. This is a notable strength as this system made it possible to compare SES between and across studies. Operationalising SES using four facets is a strength of the current study. Much of the previous literature examining the moderating effect of SES on health behaviours used single-indicator SES measures (e.g. education level, income or occupational status alone). Although interrelated, these indicators cannot be used interchangeably when investigating diet and SES otherwise inconsistent conclusions may be drawn. (Galorbardes, Morabia, & Bernstein, 2001; Turell et al., 2003). Therefore, by having four separate indicators of SES, this study was able to investigate the role of SES more comprehensively by looking at the individual effects of different facets.

Implications

This study was the first to examine the relationships between TPB variables and health promoting dietary behaviour, and the results do support the predictive value of TPB variables for diet. Intention emerged as the most proximal determinant of health promoting dietary behaviour, although SES did not moderate this relationship. Similarly, the relationships between attitude, subjective norm and PBC and health promoting dietary behaviour were not moderated by SES.

These findings suggest that interventions aiming to improve diet quality should focus on helping individuals to form realistic and concrete intentions, as changing intentions is likely to result in a change in behaviour. In order to strengthen the intention-behaviour relationship, interventions aiming to improve dietary behaviour should aim to enhance individuals' planning skills, enabling them to form action plans and implementation intentions in order to successfully effect behavioural change (Adriaanse et al., 2011). Such interventions can be aimed at all individuals regardless of their SES.

Future studies should employ different operationalisations of SES including both area-level, individual-level and subjective SES (Adler et al., 2000) measures in order to gain a more comprehensive understanding of the role of SES in the self-regulation of health promoting dietary behaviour. Future studies should also be more consistent in these SES measures and aim to use objective measures of dietary behaviour. It would also be beneficial to replicate these analyses but examine different kinds of dietary behaviour (e.g. fruit only). To further enhance understanding, future research should consider measuring the correlations between TPB variables and SES in order to be able to run more sophisticated meta-analyses on these correlations.

It may also be beneficial to extend beyond the social-cognitive predictors outlined in the TPB, as oversimplification is a major criticism of the theory (e.g., Head & Noar, 2014; Sniehotta, Presseau, & Araújo-Soares, 2014). It is likely the relations between social-cognitive predictors and dietary behaviour are subject to considerable individual variability (Chen & Miller, 2013) that extends beyond a potential moderation effect of SES. What determines an individual's dietary behaviour is a multifaceted process involving biopsychosocial influences that are relative to person, place and time (Walsh & Nelson, 2010). Numerous factors influence dietary behaviours such as convenience, access and availability, cultural norms, taste preferences, religion, environmental triggers, social support, time, habit, skills, familiarity and tradition to name a few (Turrel & Vandevijerve, 2015). Indeed, some of these factors (e.g. habit) have been shown to moderate the relationships between TPB variables and diet (de Bruijn et al., 2007). Therefore, moving beyond the TPB is likely to allow researchers to gain a deeper understanding of the social-cognitive predictors of dietary behaviour, and if they differ by SES.

Conclusion

The current systematic review investigated whether SES moderates the associations between social-cognitive TPB constructs and health promoting dietary behaviour in adults. SES was operationalised using four facets: race (majority or minority); occupation (blue or white collar and employed or unemployed); and income and education following a standardised point system (Lampert et al., 2013). None of the SES indictors emerged as significant moderators of the relationships between TPB variables and health promoting dietary behaviour. The results of the current study indicate that there is no compelling evidence for a socioeconomic patterning of the associations between TPB variables and health promoting dietary behaviour.

Diet-related disparities among different SES groups is a pressing issue in society and it is therefore imperative to gain a deeper understanding of why such inequalities exist in order to address this issue with effective, theory-based interventions. The current systematic review revealed that one’s intention to engage in health promoting dietary behaviour, as conceptualised by the TPB (Ajzen, 1991) is a significant and positive predictor of such behaviour. This suggests that if one has strong intentions to engage in health promoting dietary behaviour their SES, whether high or low, does not moderate this relationship. PBC was the next strongest predictor of health promoting dietary behaviour. Therefore, interventions targeting the intention-behaviour gap, or PBC-behaviour gap may be effective for improving diet quality regardless of one’s SES.

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(Articles marked with * were included in the systematic review and meta-analysis)

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Appendix A

Calculation Basis for Education and Income SES Indicators

Tab. 1 Calculation basis for the index of the socioeconomic status (SES Index) in DEGS1 (2012) For information on how points are awarded, cf. Lampert et al. [4]

Points	School and professional qualification	Professional status of respondents or of the head of household	Net equivalent income
1.0–1.9	No school *and* no professional qualification (1a: 1.0) Certificate of Primary Education ("Hauptschulabschluss") *and* no vocational qualification (1b: 1.7)	Farmer: 10 ha and more (1.0) Farmer, no details provided (1.0) Farmer: Under 10 ha (1.1) Unskilled workers (1.3) Semi-skilled workers (1.8) Workers, no details provided (1.9)	≤491 € (1.0) 492–683 € (1.5)
2.0–2.9	Certificate of Secondary Education ("Mittlerer Schulabschluss", "Realschulabschluss") or POS certificate and no vocational qualification (2b: 2.8)	Foreman, group leader (2.0) Skilled or specialist tradesmen (2.1) Master, site foreman, overseer, (2.4) Employees with executing responsibilities (2.4) Others, no details provided (2.9) Civil servants in Lower Service (2.9)	684–815 € (2.0) 816–921 € (2.5)
3.0–3.9	No school or primary certificate *and* training/apprenticeship/vocational school (1c: 3.0) Certificate of Secondary Education, POS *and* training/apprenticeship/vocational school (2a: 3.6) Technical college qualification ("Fachhochschulreife"), University Entrance Qualification ("Abitur"), EOS *and* no vocational qualification (2c-gen: 3.7)	Self-employed: no staff (3.5) Employees doing qualified work (3.6) Self-employed: 1–4 staff (3.6) Employees, no details given (3.7) Self-employed in trading, business etc. (3.9)	922–1082 € (3.0) 1083–1188 € (3.5)
4.0–4.9	Technical college qualification, University Entrance Qualification, EOS and training/apprenticeship/vocational school (2c-voc: 4.8)	Self-employed or freelancer, no details given (4.0) Civil servants in Intermediate Service (4.1) Employees in a position of responsibility (4.2) Self-employed: 5 or more employees (4.2) Self-employed: PGH member (4.2) Employees with extensive leadership responsibilities (4.7)	1189–1310 € (4.0) 1311–1417 € (4.5)
5.0–5.9	Category not taken	Civil servants, no details given (5.0) Civil servants in Higher Service (5.2) Freelancers: no employees (5.8)	1418–1619 € (5.0) 1620–1833 € (5.5)
6.0–7.0	Technical college qualification, University Entrance Qualification, EOS and Bachelor, Technical College Diploma (3a: 6.1) Technical college qualification, University Entrance Qualification, EOS and Master/Magister/Diploma, PhD (3b: 7.0)	Freelance academics (6.2) Civil servants in Highest Service (6.4) Freelancers: 1–4 employees (6.8) Freelancers: 5 or more employees (7.0)	1834–2125 € (6.0) 2126–2692 € (6.5) ≥2693 € (7.0)

POS Polytechnic Secondary School ("Polytechnische Oberschule"), *EOS* Extended Secondary School ("Erweiterte Oberschule"), *PGH* Craftmen's Production Cooperatives ("Produktionsgenossenschaften des Handwerks").

Figure 2. Calculation basis for the education and income indicators of socioeconomic status. Adapted from Lampert, T., Kroll, L., Müters, S., & Stolzenberg, H. (2013). Measurement of socioeconomic status in the German health interview and examination survey for Adults (DEGS1). Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz. 56(5-6), 631-636. doi: 10.1007/s00103-012-1663-4.

Appendix B

Risk of Bias Assessment Graph

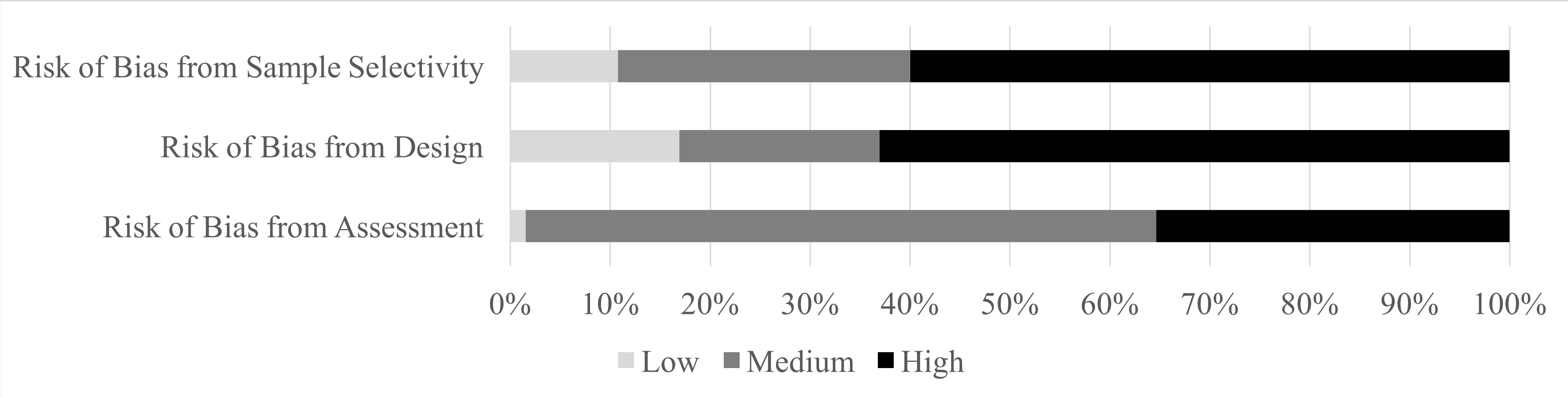

Figure 3. Risk of bias from assessment (objective vs. validated vs. subjective), risk of bias from design (cross-sectional vs. shortitudinal vs. longitudinal), risk of bias from sample selectivity (homogenous vs. community sample vs. representative).

Appendix C

PRISMA Checklist for the Reporting of Systematic Reviews

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	2-13
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	12-13
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	http://www.crd.york.ac.uk/PROSPERO CRD42016036092
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	13-15
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	13
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	13
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	13-14, figure 1
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	17-18, figure 1

Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	17-18
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	19-20
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	18-19
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	18-19

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	19-20
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	19
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	16, figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	72-80
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	21-22, 68
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	81-104
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	22-23, Table 1,
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	12
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	23-27, Table 2.

DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	32-38
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	38-41
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	42-44
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	n/a

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: **www.prisma-statement.org**.

Appendix D

Data Extraction and Study Characteristics

Short Reference	Country of Study	Details of Behaviour	Instrument of Measure	Follow -up	R INT-BEH (N)	R ATT-BEH(N)	R SN-BEH(N)	R PBC-BEH(N)	Education (Points)[1]	Education (Median Split)	Income (Points)[2]	Income (Median Split)	Occupational Status	Blue vs. White Collar	Race
(Aghamolaei,Tavafian & Madani, 2012)	Iran	Self-reported fish consumption	1-item FFQ	-/-	.64(321)	.67(321)	.67(321)	.66(321)	Certificate of Secondary Education (2.8)	Low	-/-	-/-	-/-	-/-	Majority
(Allom & Mullan, 2012)	Australia	Self-reported fruit & veg consumption	Block brief FFQ	1 week	.33(209)	-/-	-/-	-/-	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Majority
(Blanchard, Fisher, Sparling, Shanks, Nehl, Rhodes, Courneya & Baker, 2009) combined sample	Canada	Self-reported fruit & veg consumption	FFQ:Modified Nutrition Module of the behavioural risk factor surveillance system (BRFSSO)	-/-	.32(511)	.16(511)	.17(511)	.30(511)	Undergraduate Students (4.8)	High	-/-	-/-	Unemployed	-/-	Minority
(Blanchard, Fisher, Sparling, Shanks, Nehl, Rhodes, Courneya & Baker, 2009) Caucasian sample	Canada	Self-reported fruit & veg consumption	FFQ:Modified Nutrition Module of the behavioural risk factor surveillance system (BRFSSO)	-/-	.41(199)	.18(199)	.16(199)	.35(199)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Majority
(Blanchard, Fisher, Sparling, Shanks, Nehl, Rhodes, Courneya & Baker, 2009) African American sample	Canada	Self-reported fruit & veg consumption	FFQ:Modified Nutrition Module of the behavioural risk factor surveillance system (BRFSSO)	-/-	.26(241)	.11(241)	.07(241)	.23(241)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Minority

(Blanchard,Kupperman, Sparling, Nehl, Rhodes, Courneya & Baker, 2009) African American sample	Canada	Self-reported fruit & veg consumption	2-item FFQ	-/-	.42(237)	.04(237)	.06(237)	.17(237)	Undergraduate Students (4.8)	High	-/-	-/-	Unemployed	-/-	Minority
(Blanchard,Kupperman, Sparling, Nehl, Rhodes, Courneya & Baker, 2009) Caucasian sample	Canada	Self-reported fruit & veg consumption	2-item FFQ	-/-	.47(176)	.19(176)	.02(176)	.27(176)	Undergraduate Students (4.8)	High	-/-	-/-	Unemployed	-/-	Majority
Burg, de Vet, de Nooijer & Verplanken (2006)	The Netherlands	Self-reported fruit consumption	14-item FFQ	2 weeks	.35(916)	.38(916)	.10(916)	.35(916)	Certificate of Secondary Training (3.6)	Low	-/-	-/-	-/-	-/-	Majority
(Brouwer & Mosack, 2015) dv1	U.S.A.	Self-reported low-fat dairy consumption	FFQ	-/-	-.05(79)	-.11(79)	-.11(79)	-.07(79)	-/-	-/-	-/-	-/-	-/-	-/-	Majority
(Brouwer & Mosack, 2015) dv2	U.S.A.	Self-reported fruit consumption	FFQ	-/-	.51(79)	.21(79)	.06(79)	.15(79)	-/-	-/-	-/-	-/-	-/-	-/-	Majority
(Brouwer & Mosack, 2015) dv3	U.S.A.	Self-reported vegetable consumption	FFQ	-/-	.45(79)	.23(79)	.03(79)	.17(79)	-/-	-/-	-/-	-/-	-/-	-/-	Majority
(Brouwer & Mosack, 2015) dv4	U.S.A.	Self-reported whole grain consumption	FFQ	-/-	.33(79)	.27(79)	.16(79)	.29(79)	-/-	-/-	-/-	-/-	-/-	-/-	Majority
Carfora, Caso & Conner, 2015)	Italy	Self-reported fruit & veg consumption	1-item FFQ	4 weeks	.33(206)	.31(206)	.08(206)	.35(206)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	-/-

(Chevance, Caudroit, Romain & Boiche, 2016) Obese population	France	Self-reported consumption of various foods, computed to 'healthy eating' score	New Eating Self-Administered FFQ (Gusto et al., 2013)	-/-	.25(94)	.13(94)	-.11(94)	.24(94)	-/-	-/-	-/-	-/-	Employed	Blue Collar	-/-
(Chevance, Caudroit, Romain & Boiche, 2016) General population	France	Self-reported consumption of various foods, computed to 'healthy eating' score	New Eating Self-Administered FFQ	-/-	.34(59)	.16(59)	.22(59)	.14(59)	-/-	-/-	-/-	-/-	Employed	Blue Collar	-/-
(Conner, Sheeran, Norman & Armitage, 2000)	U.K.	Self-reported low-fat diet	2 item measure	1 year	.61(407)	.50(407)	.39(407)	.52(407)	-/-	-/-	-/-	-/-	Employed	White Collar	-/-
(Conner, Norman & Bell, 2002) DV1	U.K.	Self-reported fat-intake	33-item FFQ	6 years	.24(144)	.35(144)	.06(144)	.09(144)	-/-	-/-	-/-	-/-	Employed	White Collar	-/-
(Conner, Norman & Bell, 2002) DV2	U.K.	Self-reported fiber intake	33-item FFQ	6 years	.19(144)	.13(144)	-.07(144)	.15(144)	-/-	-/-	-/-	-/-	Employed	White Collar	-/-
(Conner, Norman & Bell, 2002) DV3	U.K.	Self-reported fruit & veg consumption	33-item FFQ	6 years	.22(144)	.17(144)	-.02(144)	.21(144)	-/-	-/-	-/-	-/-	Employed	White Collar	-/-
(Collins & Mullan, 2011)	Australia	Self-reported fruit & veg consumption	BLOCK FFQ	1 week	.36(190)	.21(190)	.09(190)	.27(190)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Majority

(de Bruijn, 2010)	The Netherlands	Self-reported fruit consumption	FFQ	-/-	.49(538)	.25(538)	.12(538)	.46(538)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	-/-
(de Bruijn, Keer, Van Den Putte & Neijens, 2012)	The Netherlands	Self-reported fruit consumption	1-item FFQ	4 weeks	.30(109)	.26(109)	.12(109)	.38(109)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	-/-
(de Bruijn, Wiedemann & Rhodes, 2014)	The Netherlands	Self-reported fruit consumption	FFQ	2 weeks	.50(413)	.28(413)	.16(413)	.51(413)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	-/-
(Godin, Amireault, Bélanger-Gravel, Vohl, Péruss & Guillaumie, 2010)	Canada	Self-reported fruit & veg consumption	Fruit & Veg Questionnaire (FV-Q)	12 weeks	.47(180)	.44(180)	-/-	.52(180)	Technical/University Entrance qualification and bachelor or TC diploma (3a) (6.1)	High	Majority had a household income above CDN $30,000. (4.5)	High	-/-	-/-	-/-
(Godinho, Alvarez & Lima, 2016)	Portugal	Self-reported fruit & veg consumption	2-item FFQ	1 week	.31 (180)	-/-	-/-	-/-	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Majority
(Hankonen, Absetz, Kinnunen, Haukkala & Jallinoja, 2014)	Finland	Self-reported fruit & veg consumption	36-item FFQ	8 weeks	.45(855)	-/-	-/-	-/-	-/-	-/-	-/-	-/-	Employed	Blue Collar	Majority
(Hankonen, Kinnunen, Absetz & Jallinoja, 2014)	Finland	Self-reported fruit & veg consumption	36-item FFQ	8 weeks	.39(854)	-/-	-/-	-/-	-/-	-/-	-/-	-/-	Employed	Blue Collar	Majority

(Jun & Arendt, 2016)	U.S.A.	Self-reported low calorie menu item selection	1 item measure	-/-	.88(744)	.54(744)	.40(744)	.03(744)	Undergraduate Students (4.8)	High	Majority household income above US $39,999 (3.5)	Low	-/-	-/-	Majority
(Keatley, Clarke & Hagger, 2012)	U.K.	Self-reported fruit & veg consumption	1-item FFQ	-/-	.54(162)	-/-	-/-	-/-	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	-/-
(Kim, Reicks & Sjoberg, 2003)	U.S.A.	Self-reported dairy product consumption	10 item BLOCK'S FFQ	-/-	.61(162)	.42(162)	.33(162)	.46(162)	Certificate of Secondary Training (3.6)	Low	-/-	-/-	-/-	-/-	Majority
(Kim, Struempler & Parmer, 2011)	U.S.A.	Self-reported vegetable consumption	5 item measure	-/-	.27(176)	.44(176)	.18(176)	.26(176)	Technical College Qualification (3.7)	Low	-/-	-/-	Unemployed	-/-	Minority
(Knäuper, McCollam, Rosen-Brown, Lacaille, Kelso & Roseman, 2011)	Canada	Self-reported fruit consumption	FFQ	-/-	.26(247)	.22(247)	.06(247)	.21(247)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Majority
(Kothe, Mullan & Amaratung, 2011)	Australia	Self-reported breakfast consumption	FFQ	4 weeks	.65(144)	.58(143)	.12(142)	.62(140)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Majority
(Kothe & Mullan, 2014)	Australia	Self-reported fruit & veg consumption	FFQ	-/-	.40(162)	.26(162)	.36(162)	.26(162)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Majority
(Kothe & Mullan, 2015)	Australia	Self-reported fruit & veg consumption	FFQ	12 weeks	.34(295)	.10(295)	.35(295)	.23(295)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Minority

(Kvaavik, Lien, Tell & Klepp, 2005) Women	Norway	Self-reported fruit & veg consumption	FFQ	8 years	.09(279)	.05(279)	-.06(279)	.27(279)	Undergraduate Students (4.8)	High	Majority household income above 299,000 NOK (4.5)	High	-/-	-/-	Majority
(Kvaavik, Lien, Tell & Klepp, 2005) Women	Norway	Self-reported whole-grain consumption	FFQ	8 years	0.03(240)	.08(279)	-.19(279)	.16(279)	Undergraduate Students (4.8)	High	Majority had household income above 299,000 NOK (4.5)	High	-/-	-/-	Majority
(Kvaavik, Lien, Tell & Klepp, 2005) Men	Norway	Self-reported fruit & veg consumption	FFQ	8 years	.00(240)	.08(240)	-.09(240)	.02(240)	Certificate of Secondary Education and training (3.6)	Low	Majority had household income above 299,000 NOK (4.5)	High	-/-	-/-	Majority
(Kvaavik, Lien, Tell & Klepp, 2005) Men	Norway	Self-reported whole-grain consumption	FFQ	8 years	0.08(240)	.01(240)	-.05(240)	.10(240)	Certificate of Secondary Education and training (3.6)	Low	Majority had household income above 299,000 NOK (4.5)	High	-/-	-/-	Majority
(Leganger & Kraft, 2003)	Norway	Self-reported fruit & veg consumption	1-item FFQ	-/-	.64(329)	-/-	-/-	-/-	Certificate of Secondary Education and training (3.6)	Low	-/-	-/-	-/-	-/-	Majority
(Liou & Contento, 2006) sample 1	U.S.A.	Self-reported dietary fat reduction behaviours	21-item FFQ	-/-	.38(600)	.35(600)	-/-	-/-	Bachelor, Technical College Diploma (6.1)	High	-/-	-/-	Employed	-/-	Minority
(Liou & Contento, 2006) sample 2	U.S.A.	Self-reported dietary fat reduction behaviours	21-item FFQ	-/-	.65(143)	.55(143)	-/-	-/-	Bachelor, Technical College Diploma (6.1)	High	-/-	-/-	Employed	-/-	Minority

(Louis, Davies, Smith & Terry, 2007)	Australia	Self-reported healthy food choices	FFQ	2 weeks	.78(116)	.51(116)	.42(116)	.48(116)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	-/-
(Louis, Davies, Smith & Terry, 2007)	Australia	Self-reported 'healthy dietary style'	FFQ	2 weeks	.51(116)	.49(116)	.21(116)	.45(116)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	-/-
(Menozzi & Mora, 2012)	Italy	Self-reported fruit consumption	FFQ	-/-	.35(692)	.08(692)	.07(692)	.34(692)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Majority
(Mitterer-Daltoé, Latorres, Queiroz, Fiszman & Varela, 2013)	Brazil	Self-reported fish consumption	FFQ	-/-	.59(200)	-.24(200)	.04(200)	.07(200)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Majority
(Mullan, Wong, Kothe & Maccann, 2013)	Australia	Self-reported breakfast consumption	FFQ	-/-	.64(102)	.52(102)	.34(102)	.60(102)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Majority
(Onwezen, Bartels, Antonides, 2014)	The Netherlands	Self-reported organic food consumption	FFQ	2 weeks	.12(491)	.06(491)	.07(491)	.05(491)	-/-	-/-	-/-	-/-	-/-	-/-	Majority
(O'Neal, Wickrama, Ralston, Ilich, Harris, Coccia, Young-Clark & Lemacks, 2014)	U.S.A.	Self-reported fruit & veg consumption	FFQ	-/-	.45(211)	.25(211)	.26(211)	.25(211)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Minority
(Payne, Jones & Harris, 2005)	U.K.	Self-reported Healthy eating dietary behaviours	FFQ	-/-	.74(286)	-/-	-/-	.45(286)	-/-	-/-	-/-	-/-	Employed	White Collar	-/-
(Povey, Conner, Sparks, James, Shepherd, 2000)	U.K.	Self-reported healthy eating style	63-item FFQ	-/-	.29(242)	.36(242)	-.01(242)	.36(242)	Technical College Qualification (3.7)	Low	-/-	-/-	Employed	-/-	-/-

(Prestwich, Perugini & Hurling, 2008)	U.K.	Self-reported fruit intake	FFQ	-/-	.43(119)	-/-	-/-	.20(119)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	-/-
(Rodgers, Conner & Murray, 2008)	Canada	Self-reported fruit & veg intake	FFQ	-/-	.57(211)	-/-	-/-	-/-	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	-/-
(Sheats, Middlestadt, Ona, Juarez & Kolbe, 2013)	U.S.A	Self-reported dark green leafy vegetable consumption	FFQ	-/-	.23(410)	-/-	-/-	-/-	Undergraduate Students (4.8)	High	Majority household income less than $25,000 USD (2)	Low	-/-	-/-	Minority
(Sjoberg, Kim & Reicks, 2004)	U.S.A	Self-reported fruit & veg consumption	FFQ All-day screener	-/-	.40(205)	.21(205)	.26(205)	.34(205)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Majority
(Tak, Te Velde, Kamphuis, Ball, Crawford, Brug & Van Lenthe, 2013)	The Netherlands	Self-reported fruit consumption	FFQ	-/-	.47(312)	.44(312)	.25(312)	.52(312)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	-/-
(Tomasone, Meikie & Bray, 2015)	Canada	Self-reported fruit & veg consumption	FFQ	-/-	.44(1151)	.22(1151)	.36(1151)	.29(1151)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Majority
(Tomić, Matulić & Jelić, 2015)	Croatia	Self-reported fresh fish consumption	FFQ	-/-	.47(76)	.28(76)	.18(76)	.37(76)	Undergraduate Students (4.8)	High	(4)	-/-	-/-	-/-	Minority
(Verbeke & Vackier, 2005)	Belgium	Self-reported fish consumption	FFQ	-/-	.64(429)	.40(429)	.35(429)	.48(429)	Technical College Qualification (3.7)	Low	Majority household income 1700-2550€ (5.5)	High	-/-	-/-	-/-

(Weijzen, de Graaf & Dijksterhuis, 2009)	The Netherlands	Self-reported healthy snack choices	FFQ	-/-	-/-	.50(702)	-/-	-/-	Technical College Qualification (3.7)	Low	-/-	-/-	Employed	Blue Collar	-/-
(White, Terry, Troup, Rempel & Norman, 2010)	Australia	Self-reported low-sat-fat food consumption	1 item measure and FFQ	4 weeks	.35(167)	.30(167)	.22(167)	.14(167)	-/-	-/-	-/-	-/-	Unemployed	-/-	Majority
(Wilson, O’Conner, Lawton, Hill & Roberts, 2016)	U.K.	Self-reported fruit & veg consumption	Behavioural Risk Factor Surveillance System	-/-	.46(2031)	-/-	-/-	-/-	-/-	-/-	-/-	-/-	Employed	-/-	Majority
(Wong & Mullan, 2009)	Australia	Self-reported breakfast consumption	FFQ	4 weeks	.80(96)	.57(96)	.19(96)	.63(96)	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	Majority
(Wood, Conner, Sandberg, Godin & Sheern, 2014)	U.K.	Observed healthy food choice	Food Choice Paradigm	-/-	-/-	-.20(151)	-/-	-/-	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	-/-
(Zhou, Gan, Miao, Hamilton, Knoll & Schwarzer, 2015)	Germany	Self-reported fruit & veg consumption	FFQ	4 weeks	.22(286)	-/-	-/-	-/-	Undergraduate Students (4.8)	High	-/-	-/-	-/-	-/-	-/-

Note. [1,2] Points derived from the Lampert et al. (2013) SES coding system.

Appendix E

Forest Plots

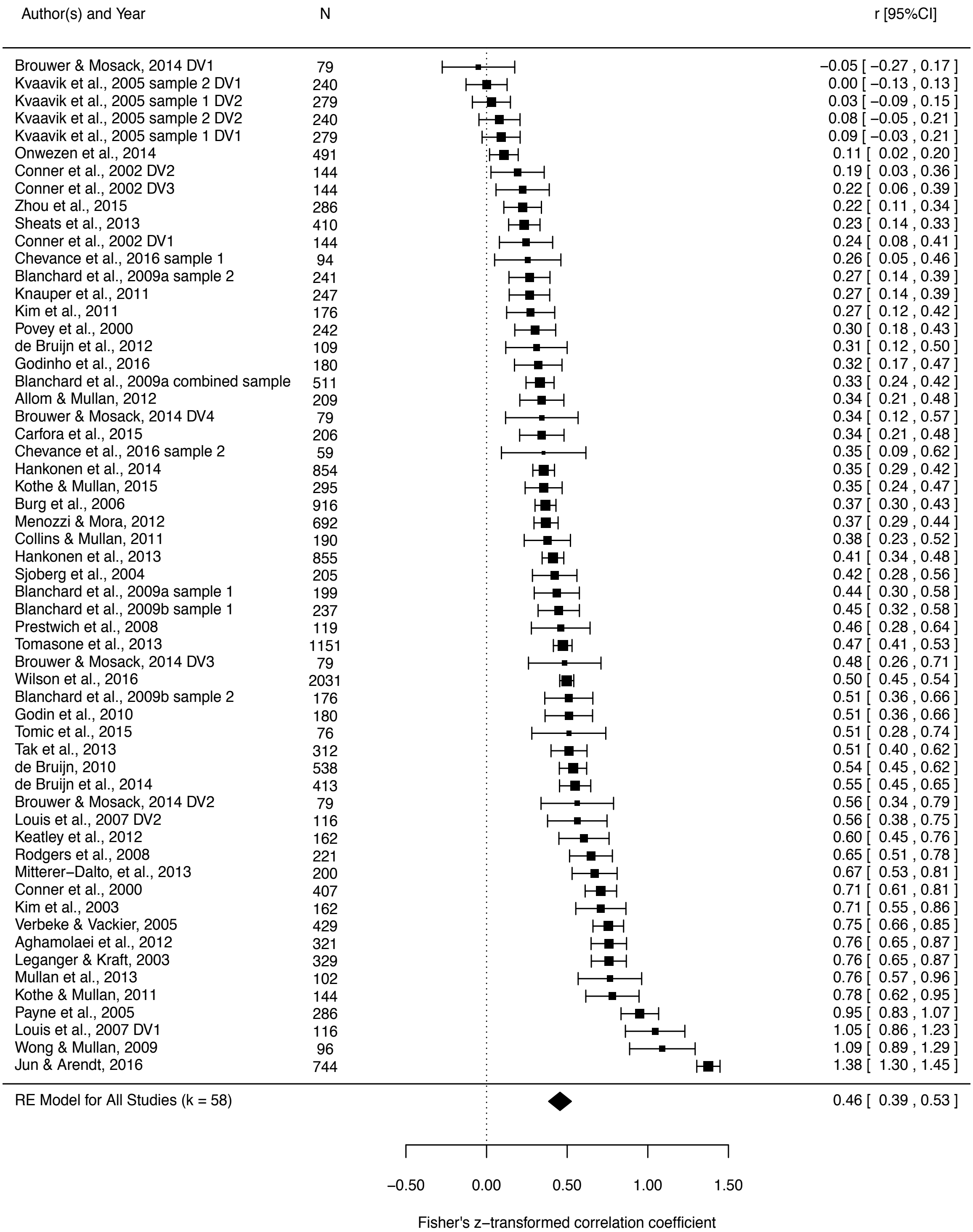

Figure 4. Correlations between intention and health promoting dietary behaviour. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The diamond at the bottom represents Fisher's z-transformed correlation. *N* refers to the sample size of studies.

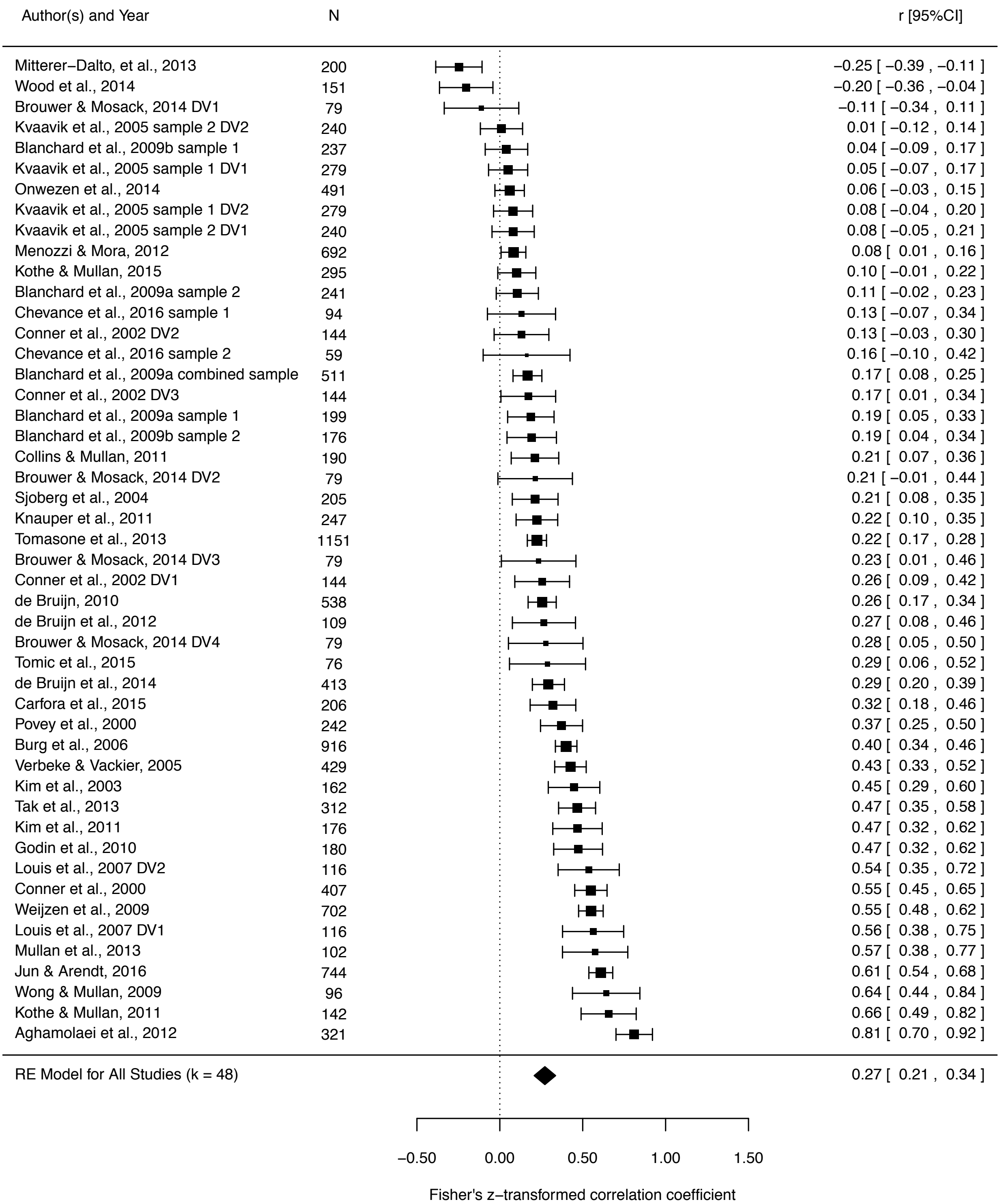

Figure 5. Correlations between attitude and health promoting dietary behaviour. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The diamond at the bottom represents Fisher's z-transformed correlation. *N* refers to the sample size of studies.

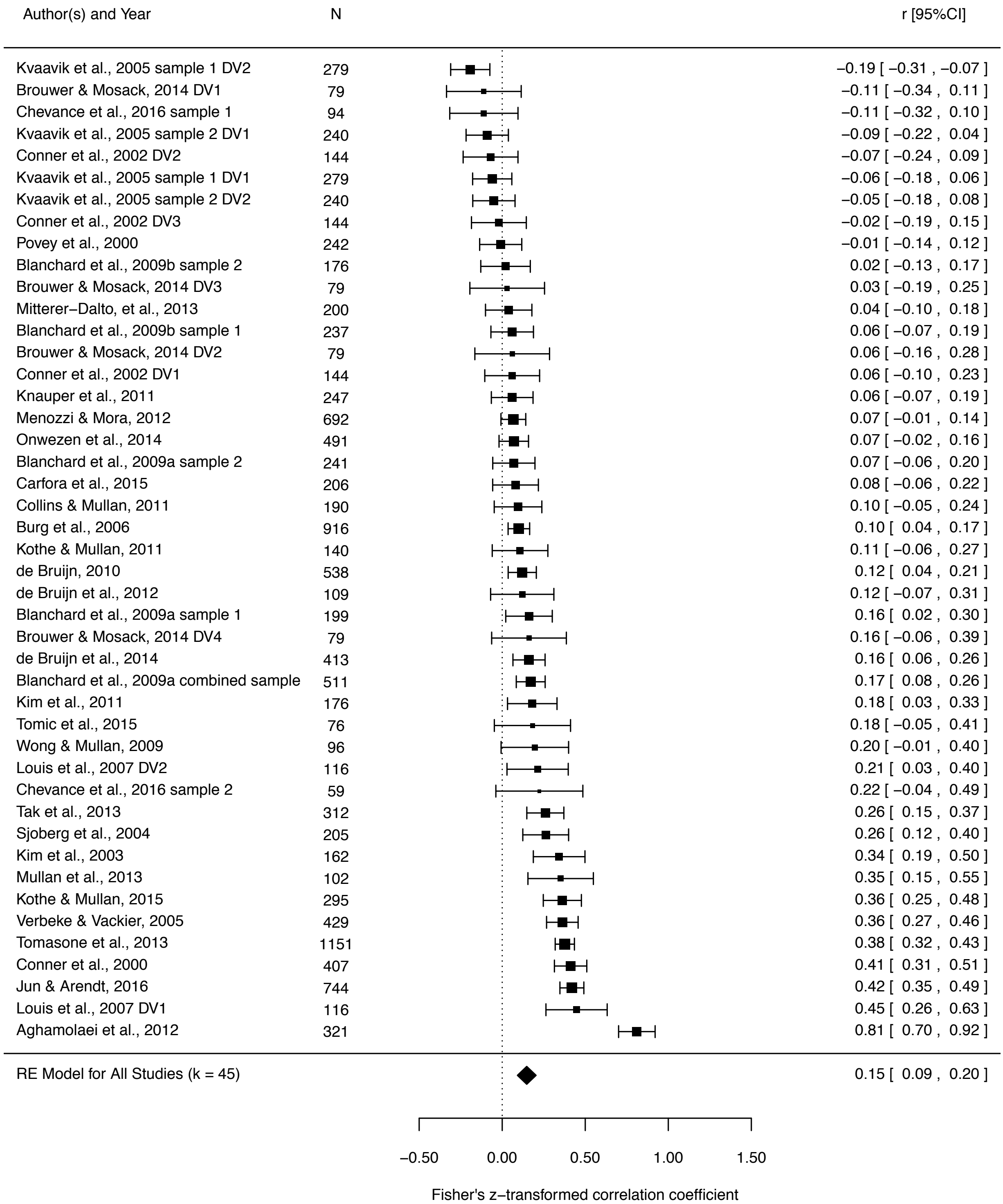

Figure 6. Correlations between subjective norm and health promoting dietary behaviour. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The diamond at the bottom represents Fisher’s z-transformed correlation. *N* refers to the sample size of studies.

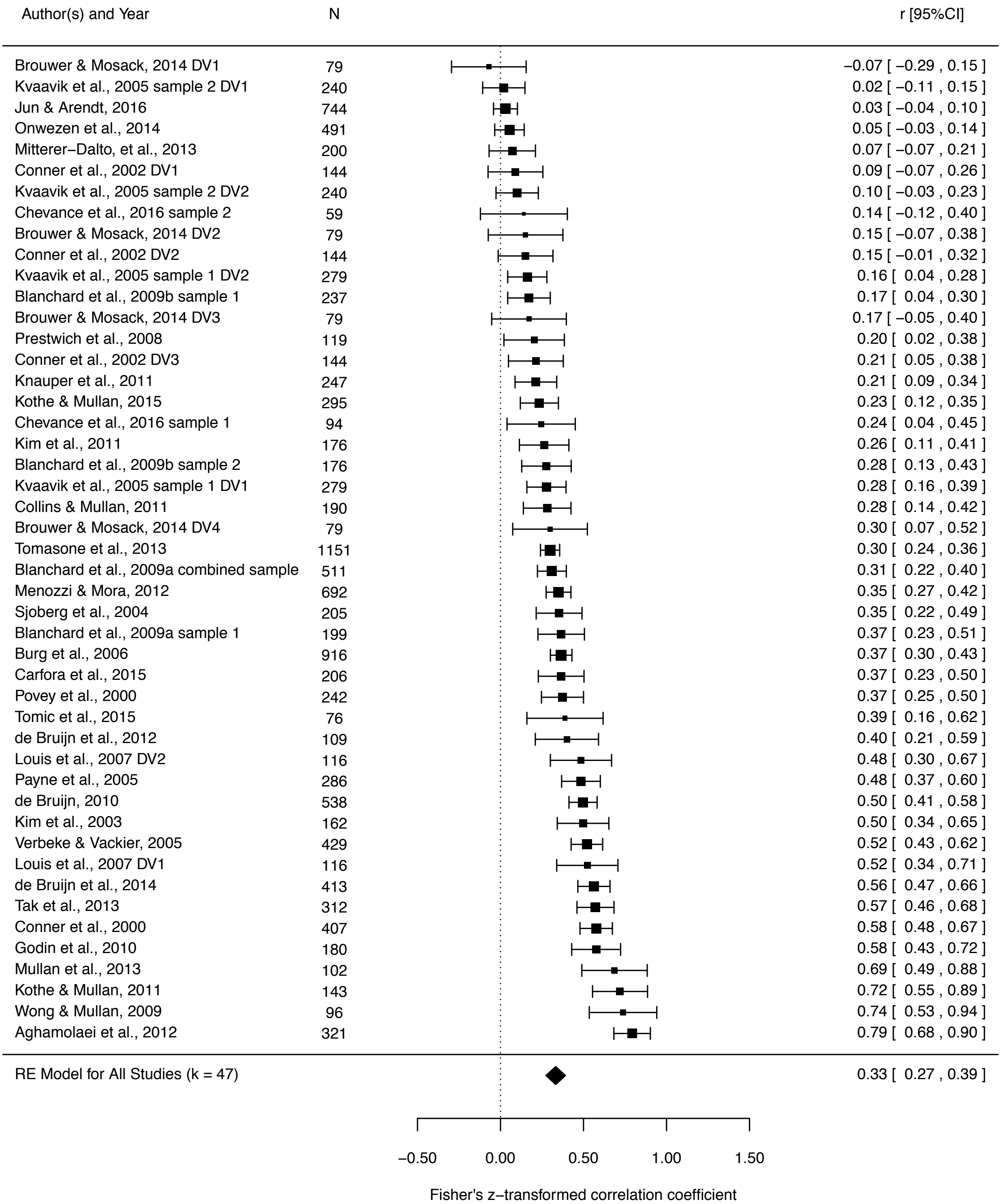

Figure 7. Correlations between perceived behavioural control and health promoting dietary behaviour. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The diamond at the bottom represents Fisher's z-transformed correlation. *N* refers to the sample size of studies.

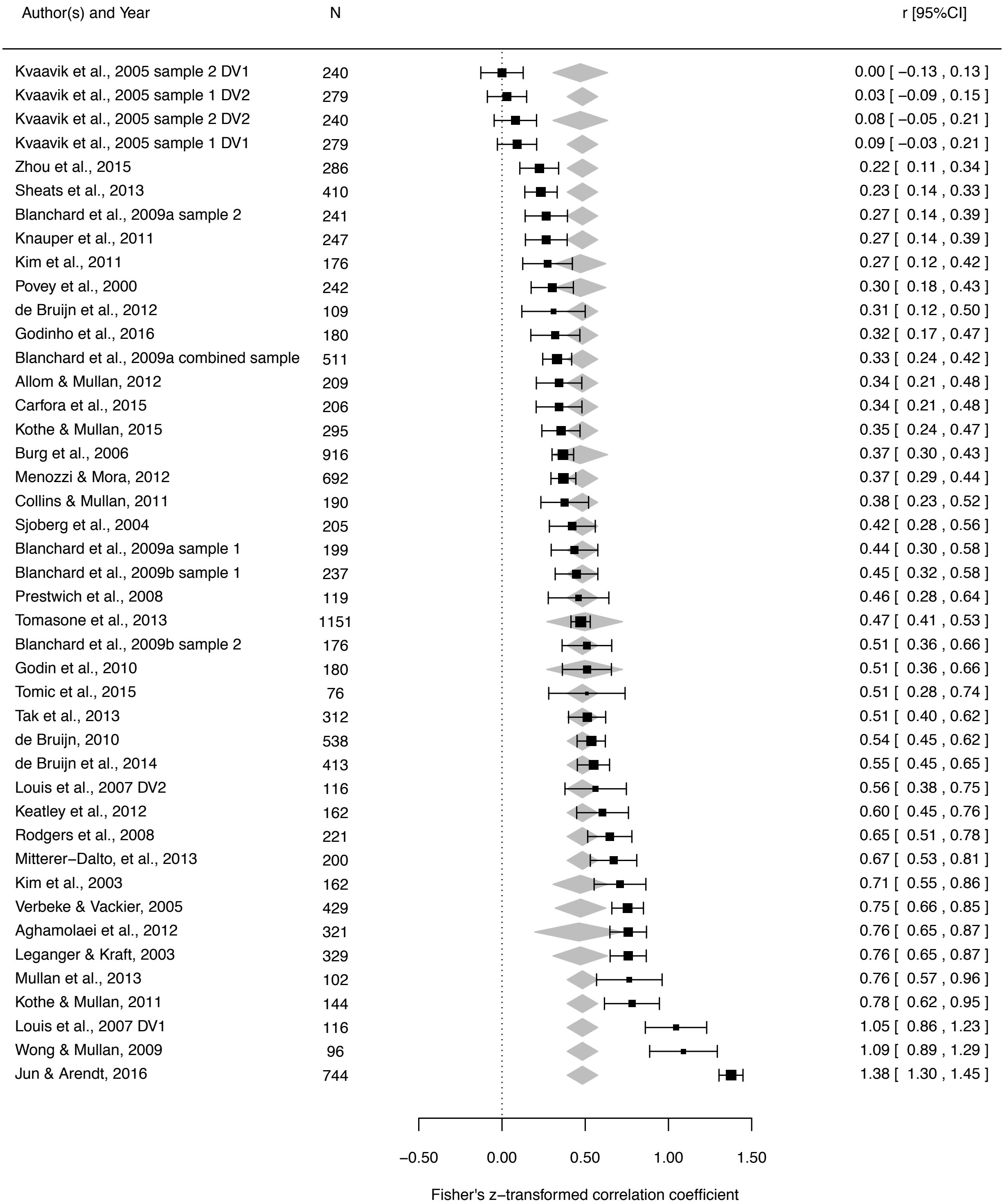

Figure 8. Fisher's z-transformed correlations between intention and health promoting dietary moderated by education. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

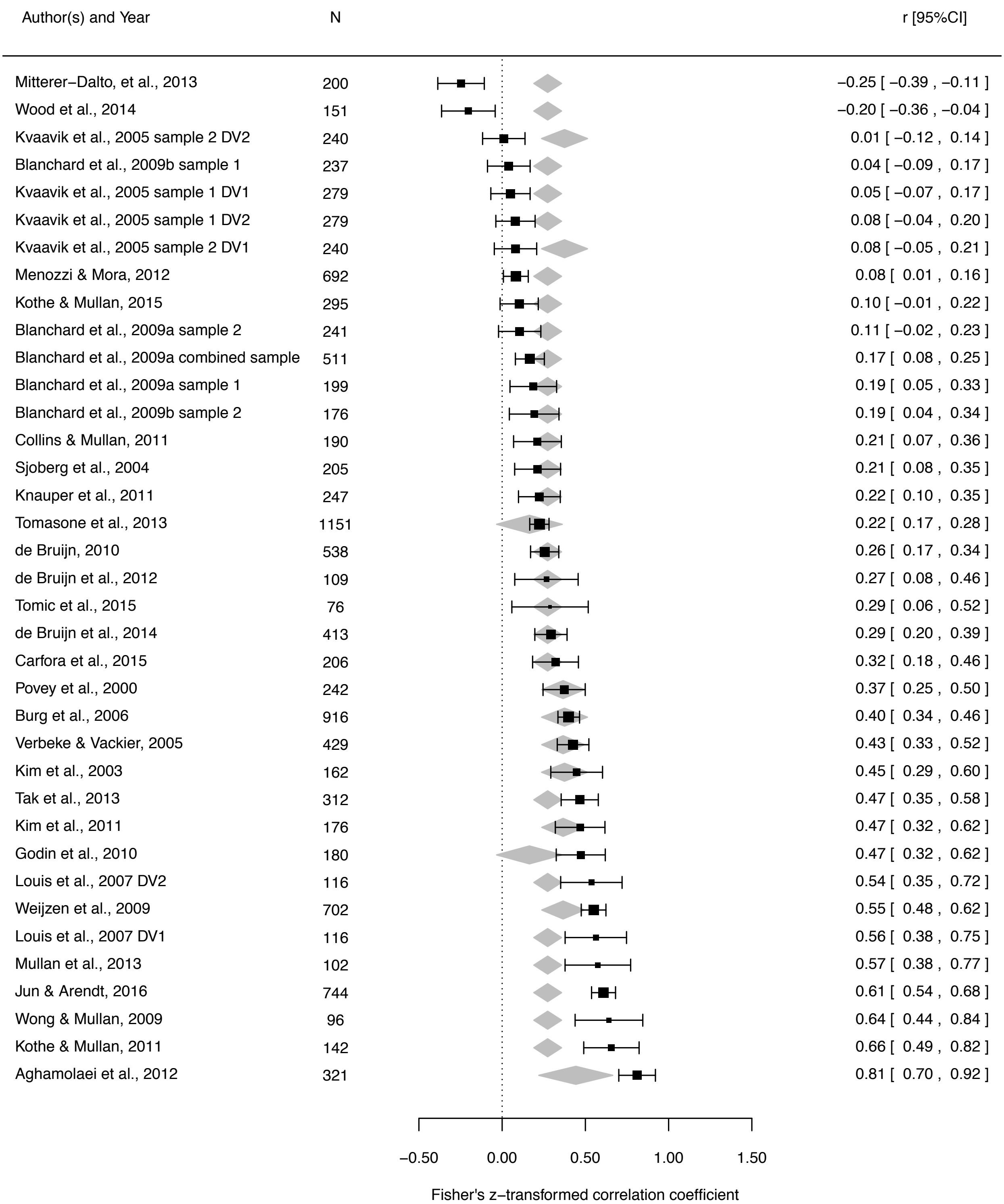

Figure 9. Fisher’s z-transformed correlations between attitude and health promoting dietary moderated by education. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

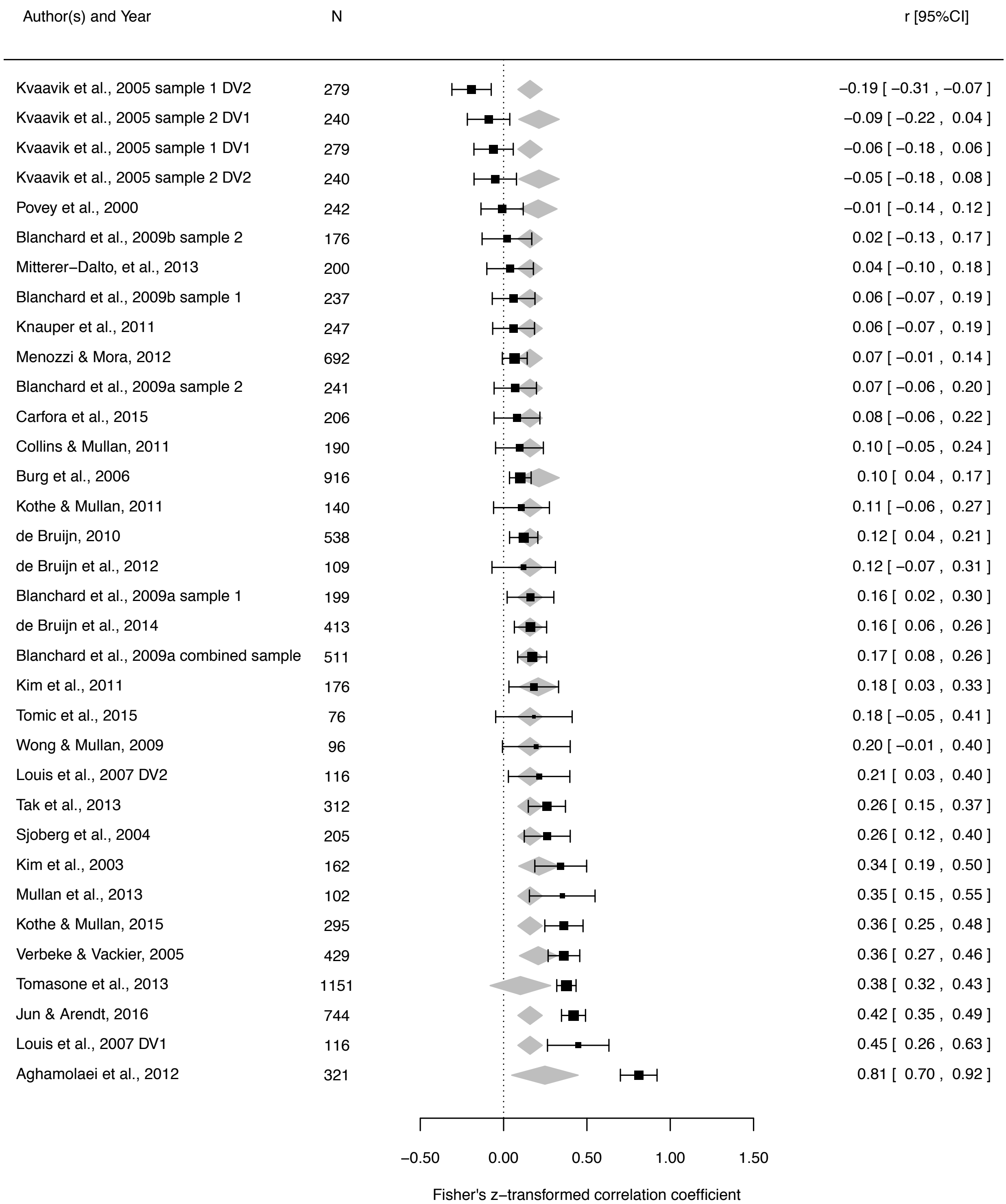

Figure 10. Fisher's z-transformed correlations between subjective norm and health promoting dietary moderated by education. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

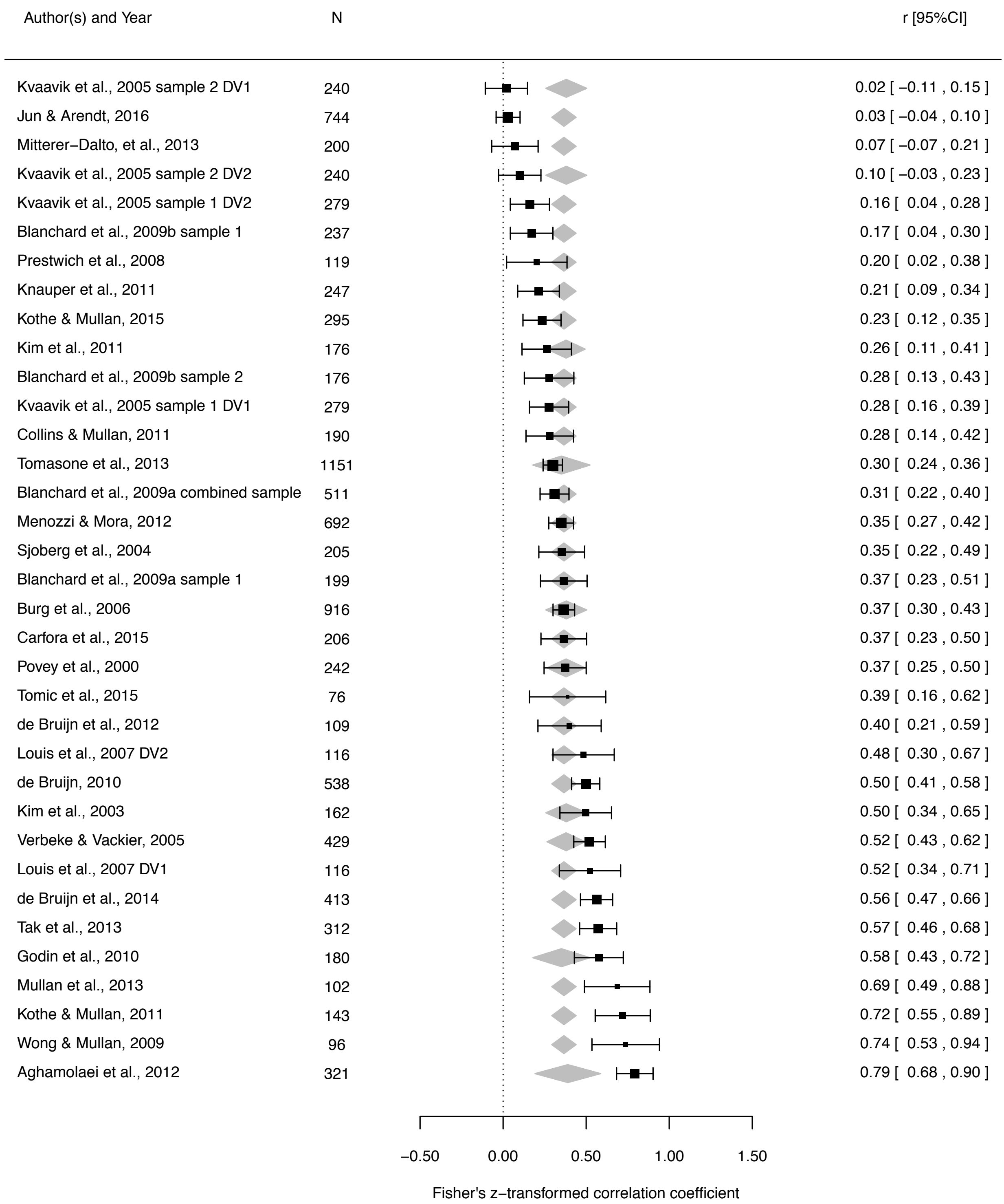

Figure 11. Fisher's z-transformed correlations between perceived behavioural control and health promoting dietary moderated by education. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

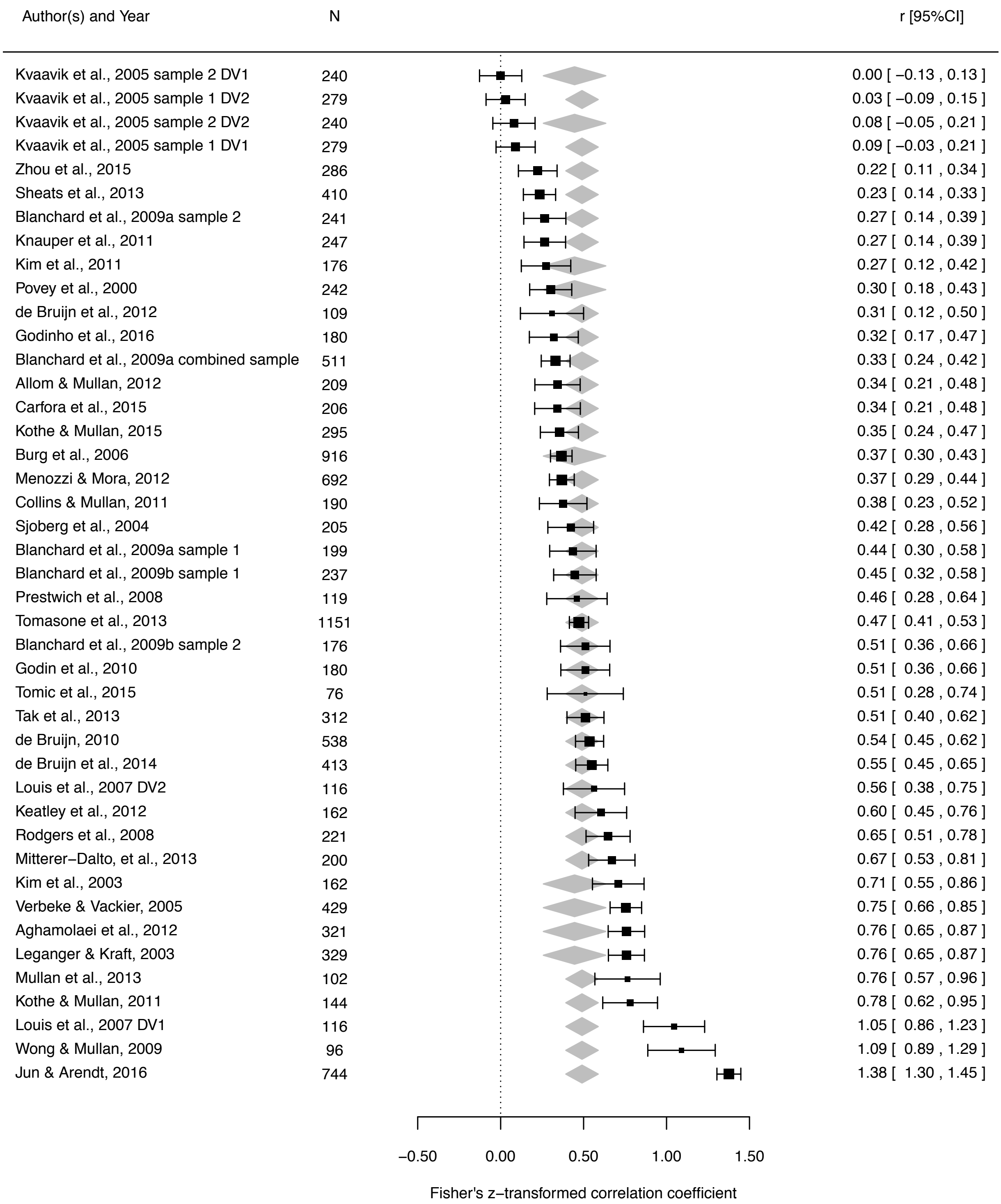

Figure 12. Fisher’s z-transformed correlations between intention and health promoting dietary moderated by education (median split). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

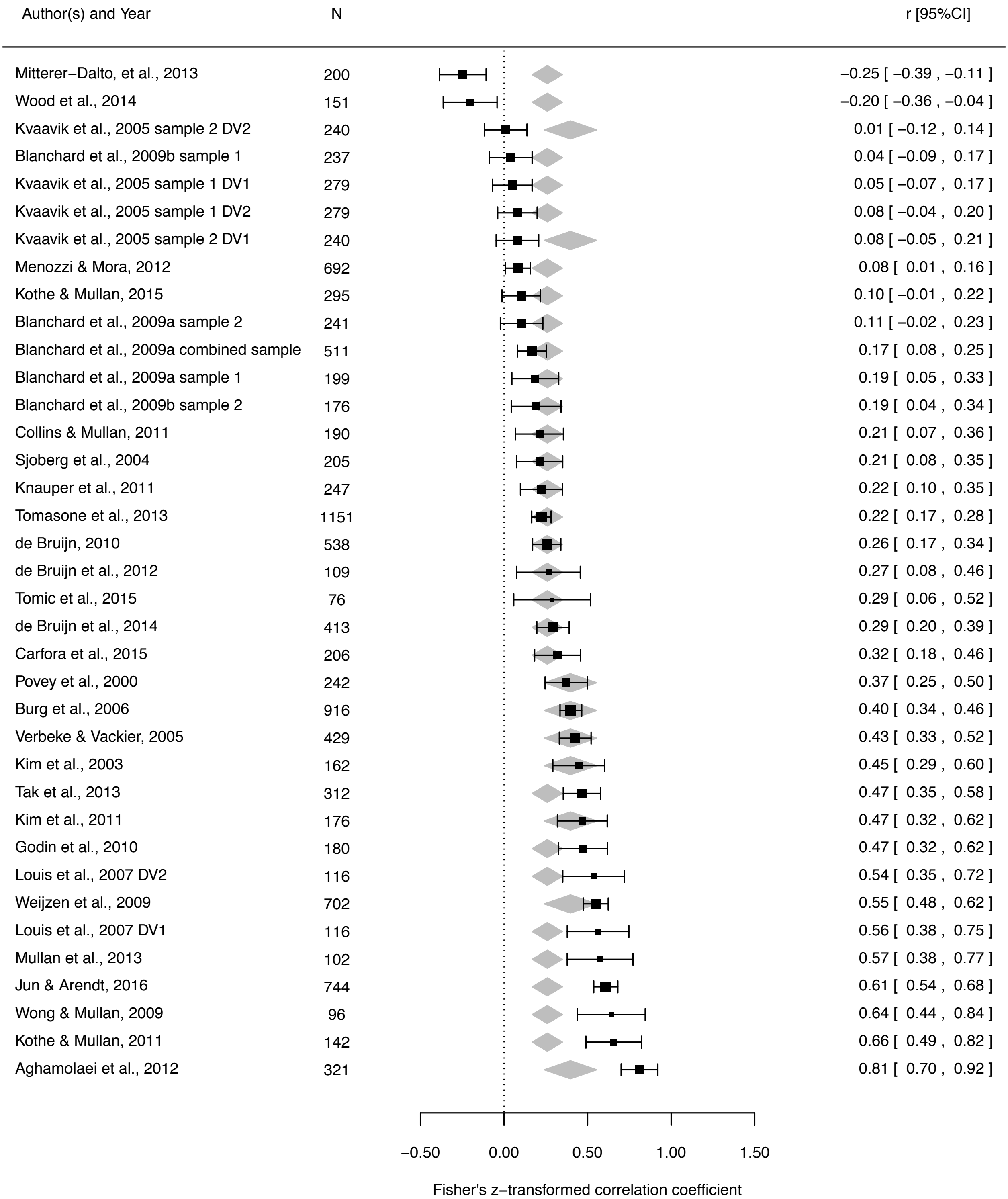

Figure 13. Fisher's z-transformed correlations between attitude and health promoting dietary moderated by education (median split). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

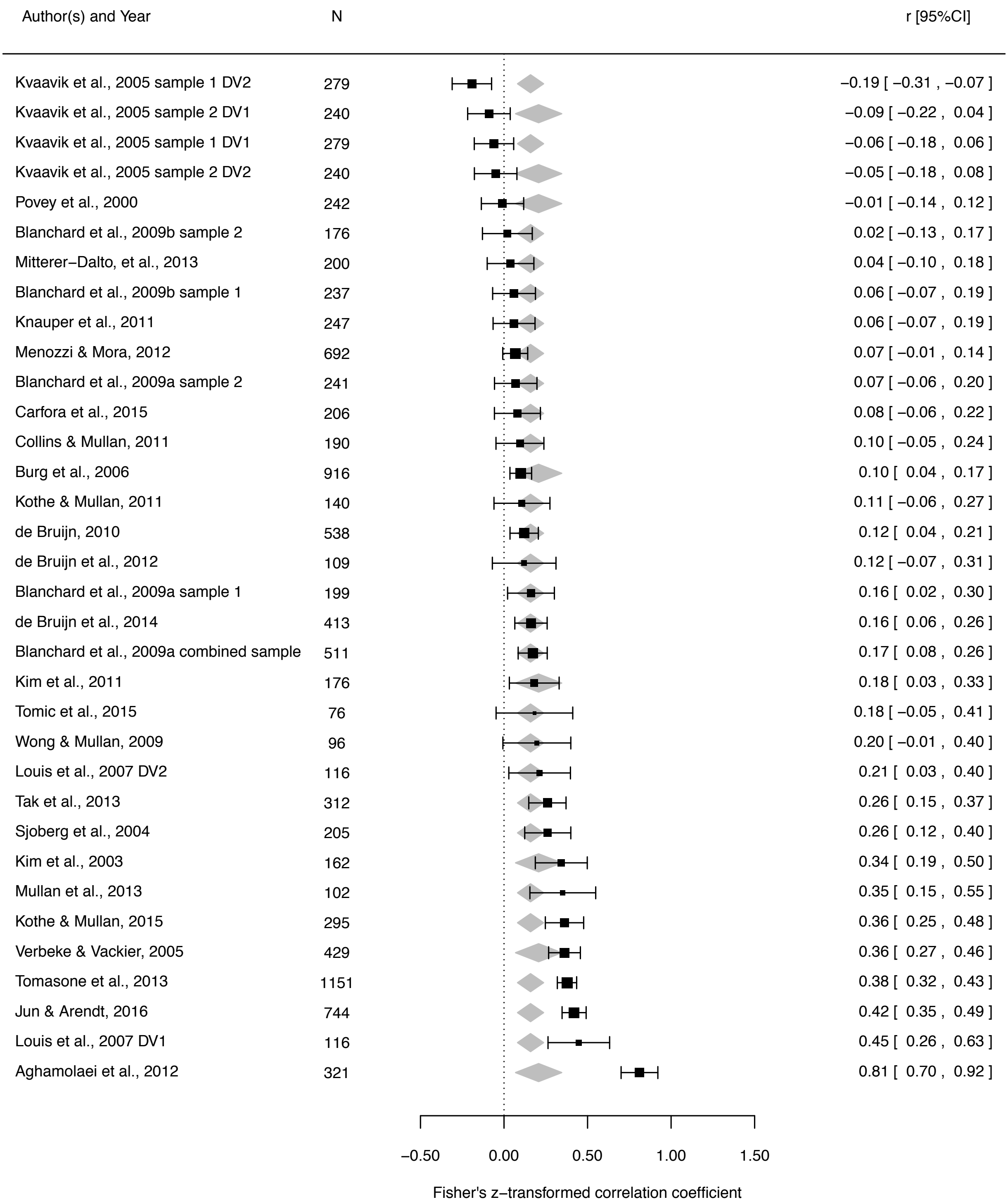

Figure 14. Fisher’s z-transformed correlations between subjective norm and health promoting dietary moderated by education (median split). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

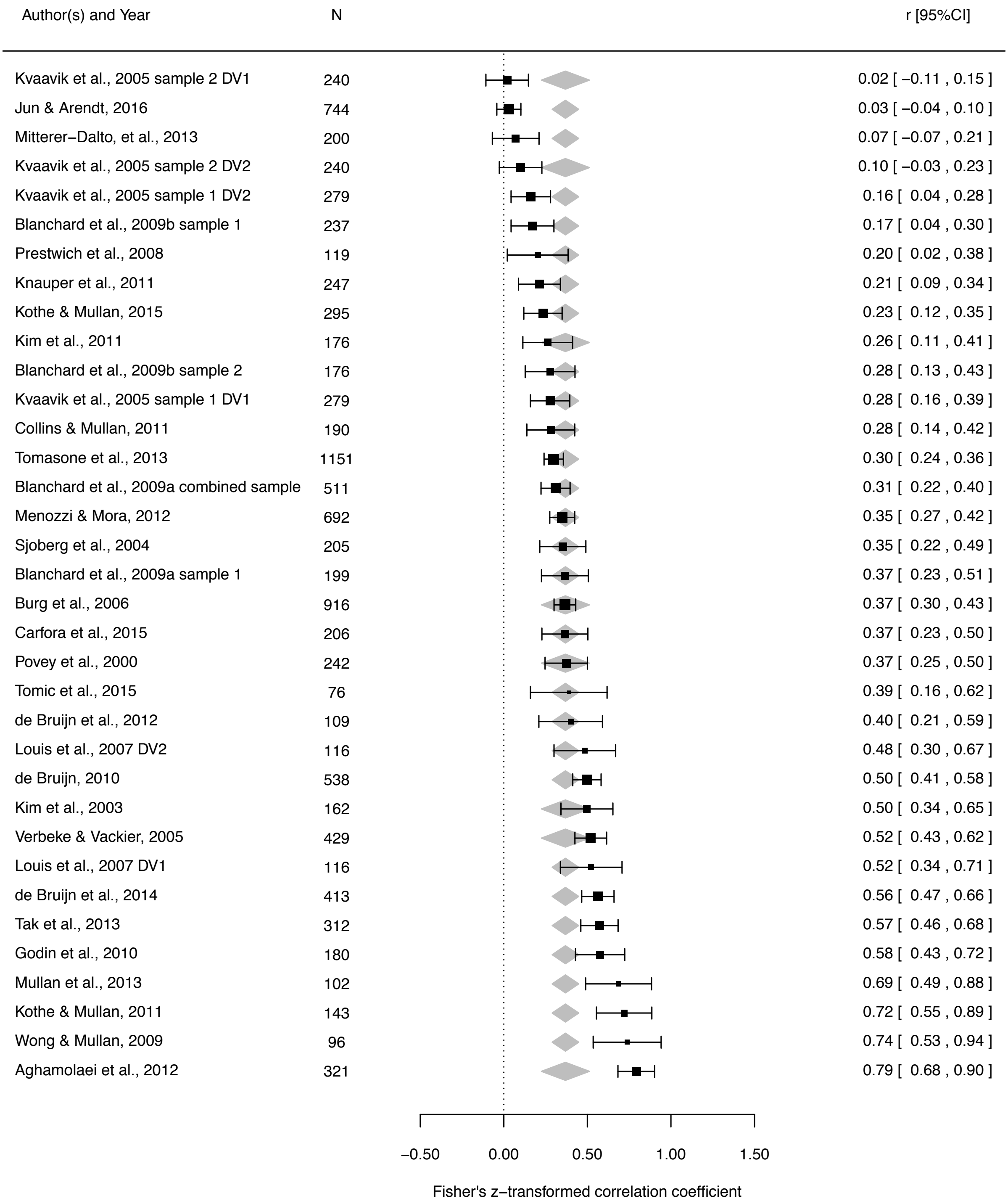

Figure 15. Fisher's z-transformed correlations between perceived behavioural control and health promoting dietary moderated by education (median split). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

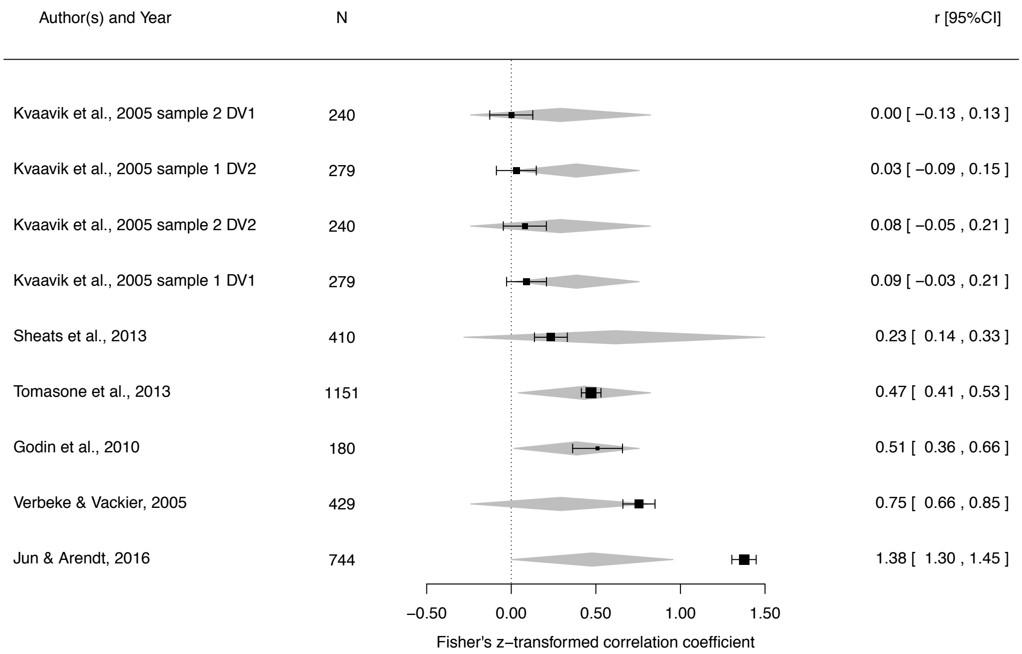

Figure 16. Fisher’s z-transformed correlations between intention and health promoting dietary moderated by income. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

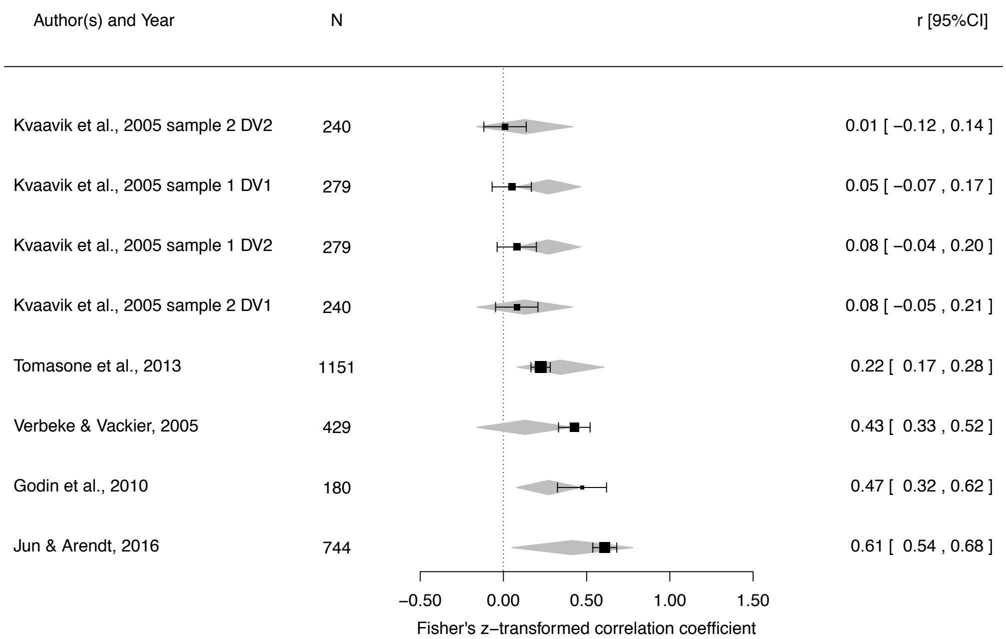

Figure 17. Fisher’s z-transformed correlations between attitude and health promoting dietary moderated by income. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

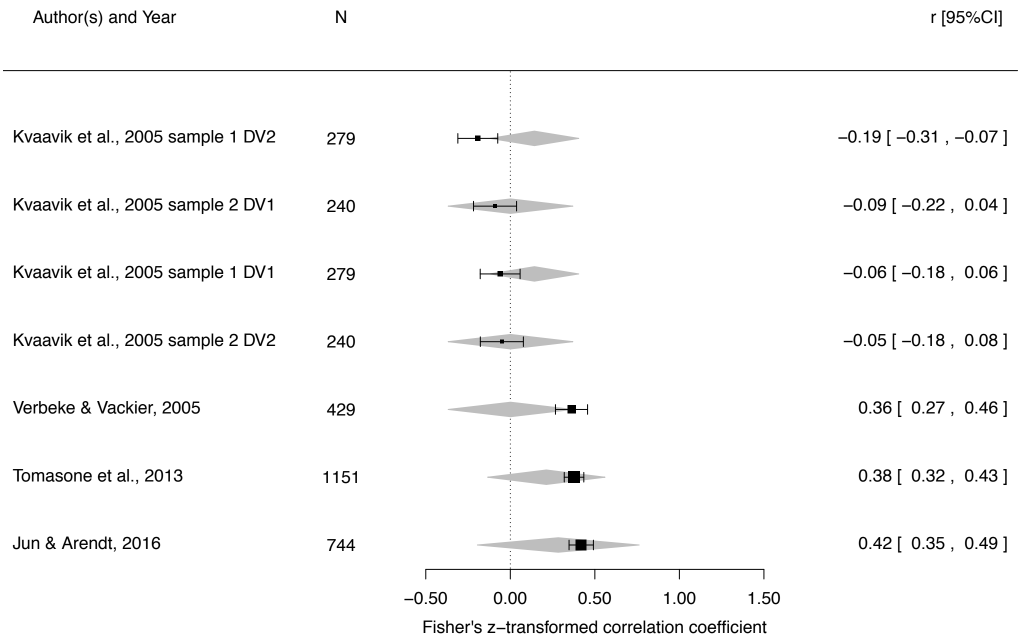

Figure 18. Fisher’s z-transformed correlations between subjective norm and health promoting dietary moderated by income. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

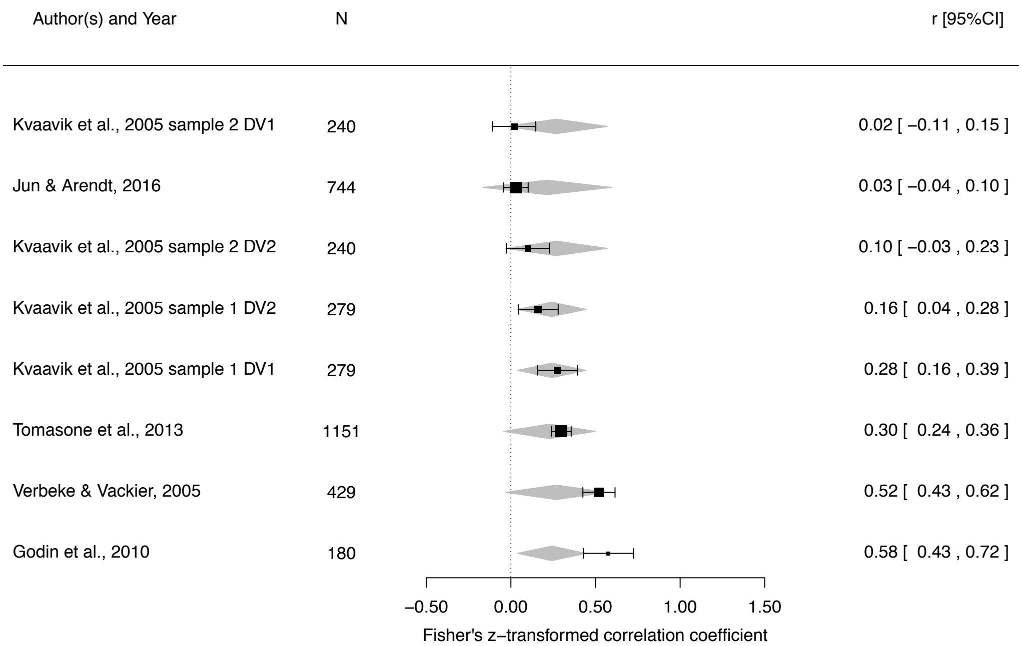

Figure 19. Fisher’s z-transformed correlations between perceived behavioural control and health promoting dietary moderated by income. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

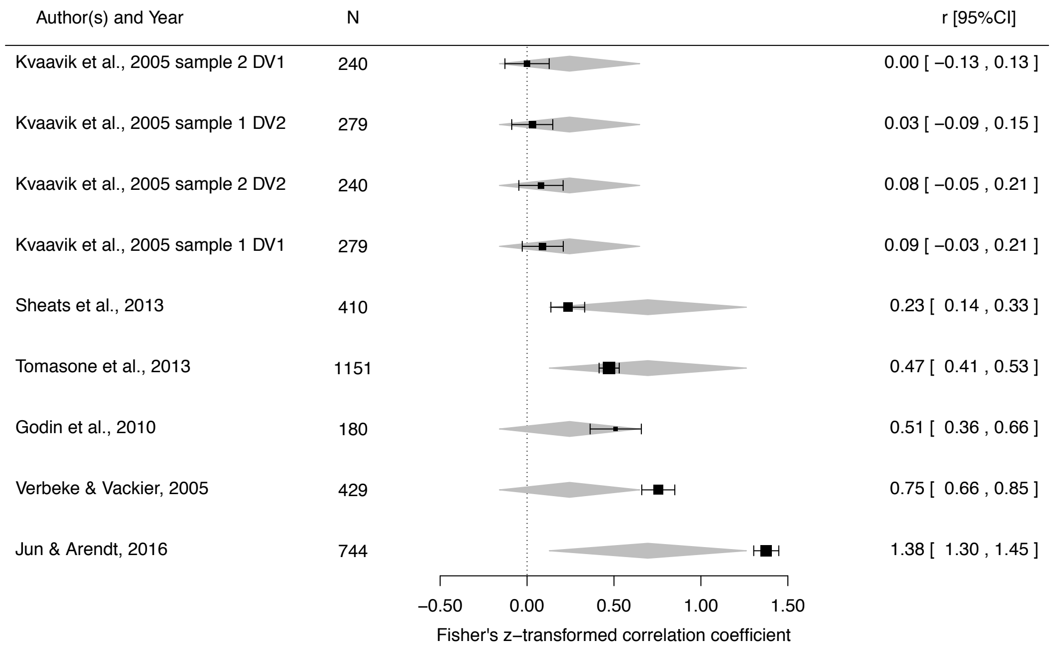

Figure 20. Fisher's z-transformed correlations between intention and health promoting dietary moderated by income (median split). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

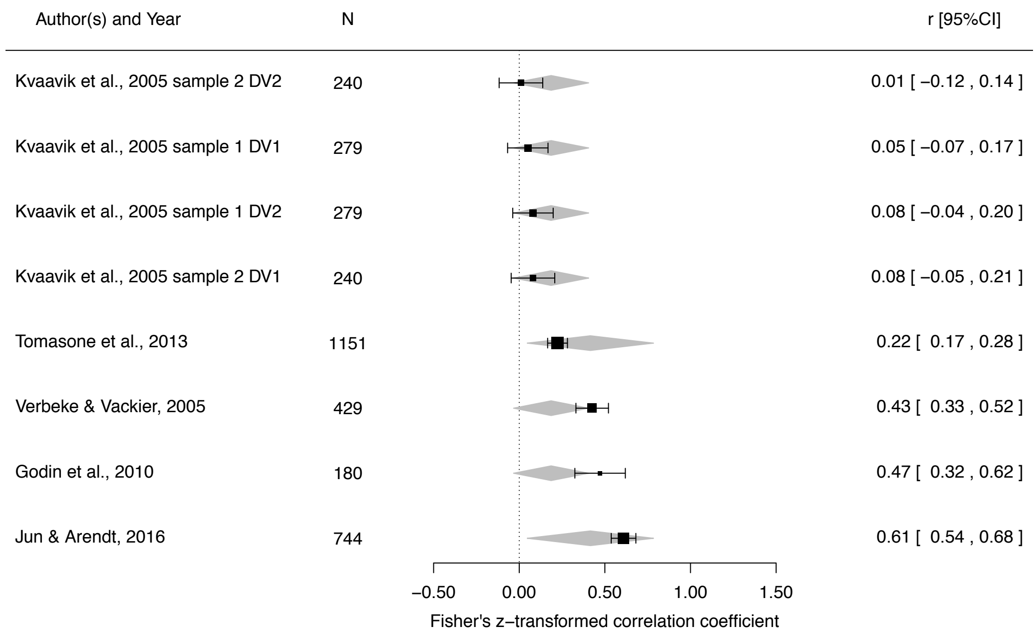

Figure 21. Fisher's z-transformed correlations between attitude and health promoting dietary moderated by income (median split). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

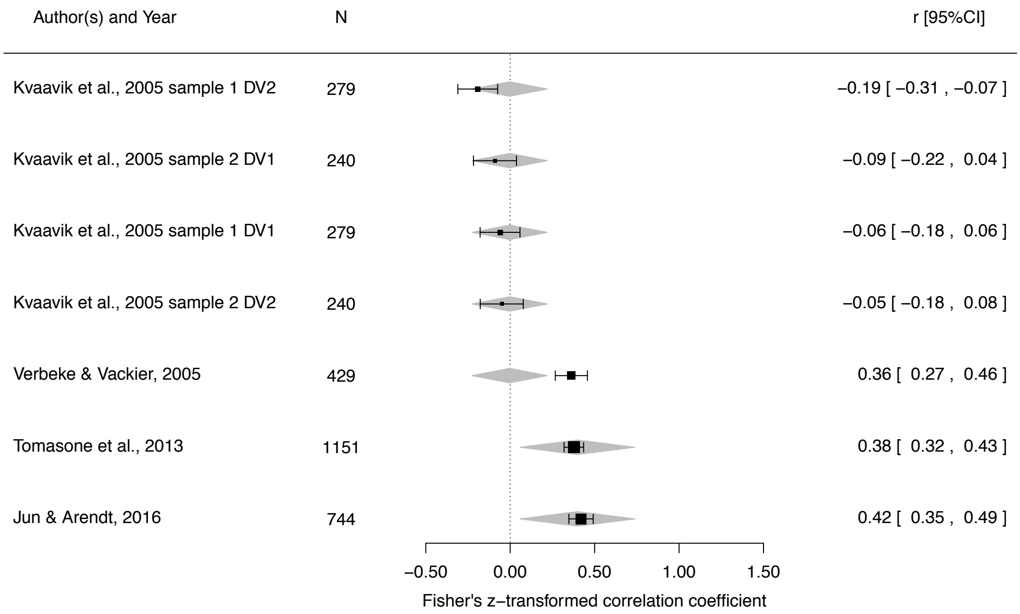

Figure 22. Fisher's z-transformed correlations between subjective norm and health promoting dietary moderated by income (median split). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

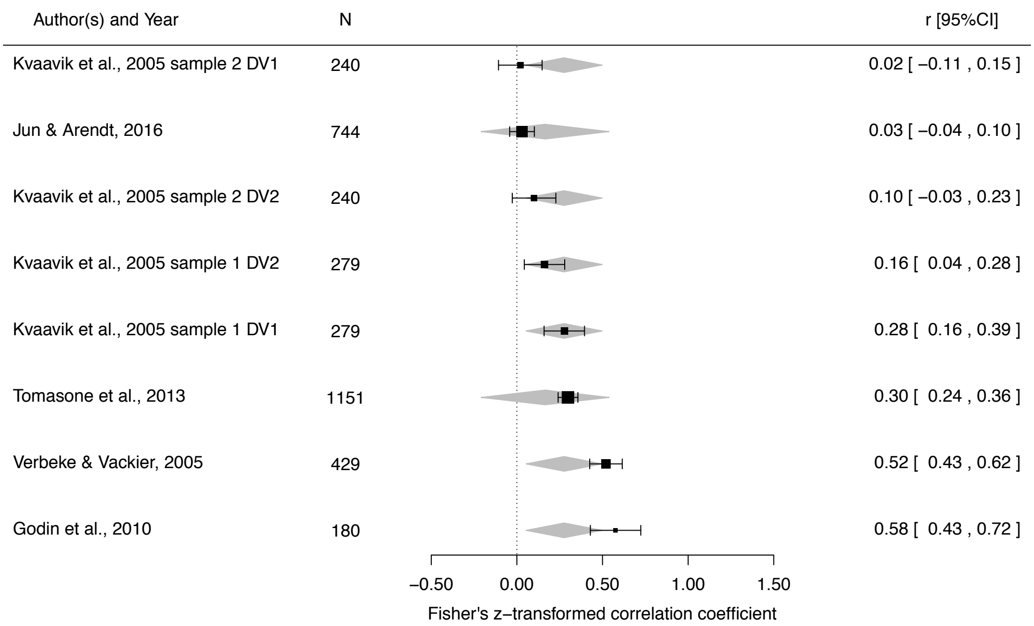

Figure 23. Fisher's z-transformed correlations between perceived behavioural control and health promoting dietary moderated by income (median split). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

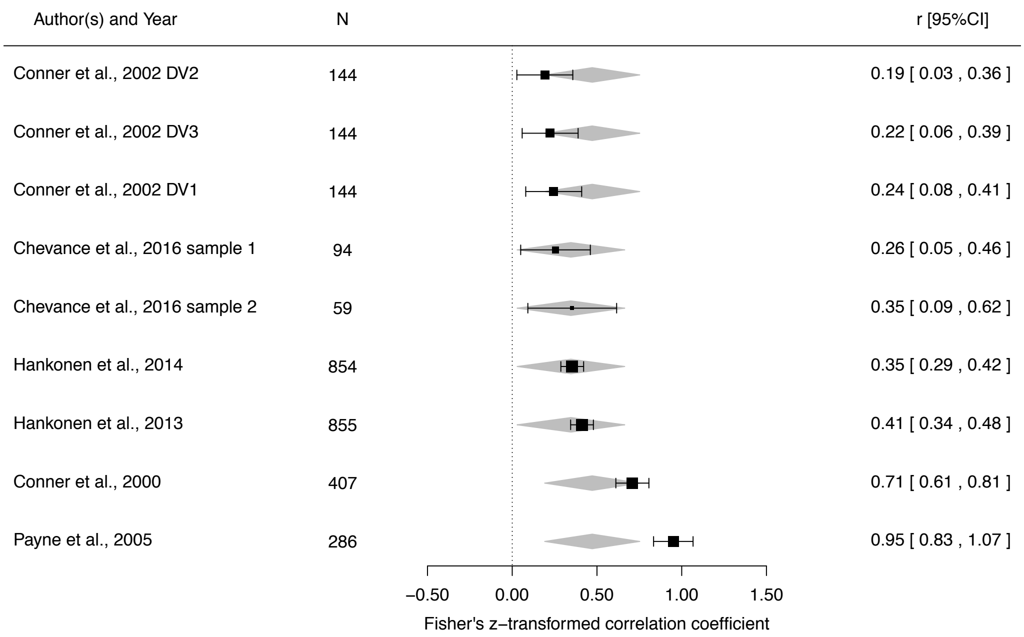

Figure 24. Fisher’s z-transformed correlations between intention and health promoting dietary moderated by occupational status (blue vs. white). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

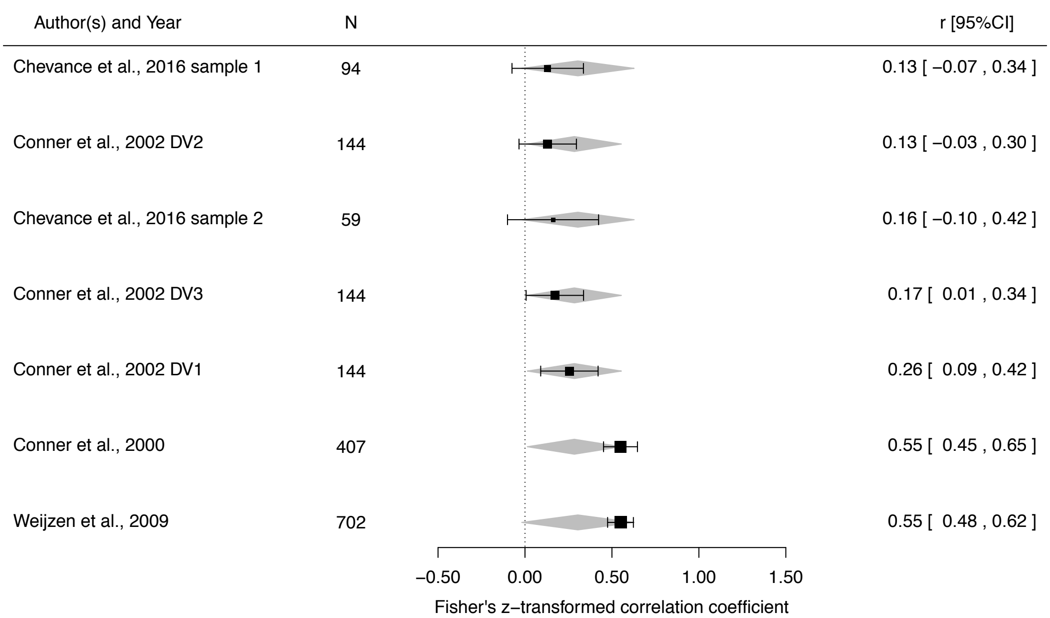

Figure 25. Fisher’s z-transformed correlations between attitude and health promoting dietary moderated by occupational status (blue vs. white). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

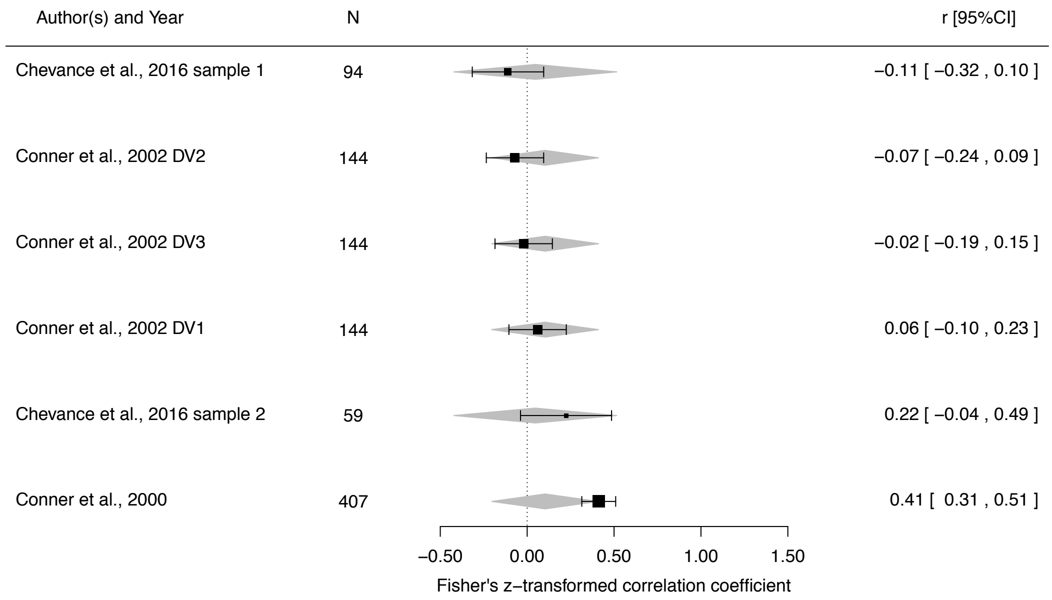

Figure 26. Fisher's z-transformed correlations between subjective norm and health promoting dietary moderated by occupational status (blue vs. white). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

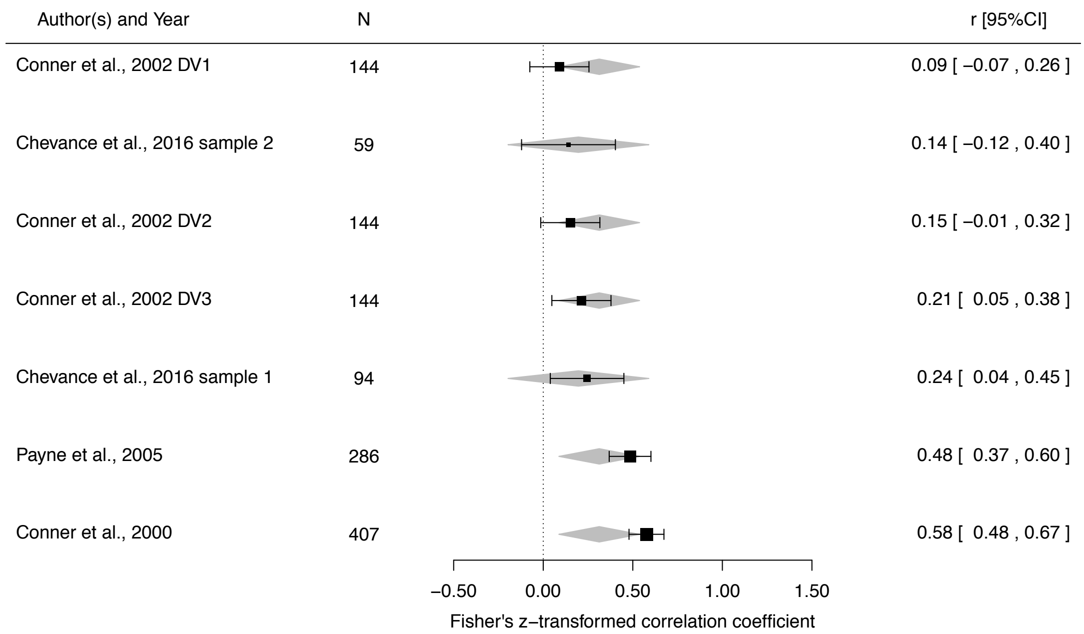

Figure 27. Fisher's z-transformed correlations between perceived behavioural control and health promoting dietary moderated by occupational status (blue vs. white). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

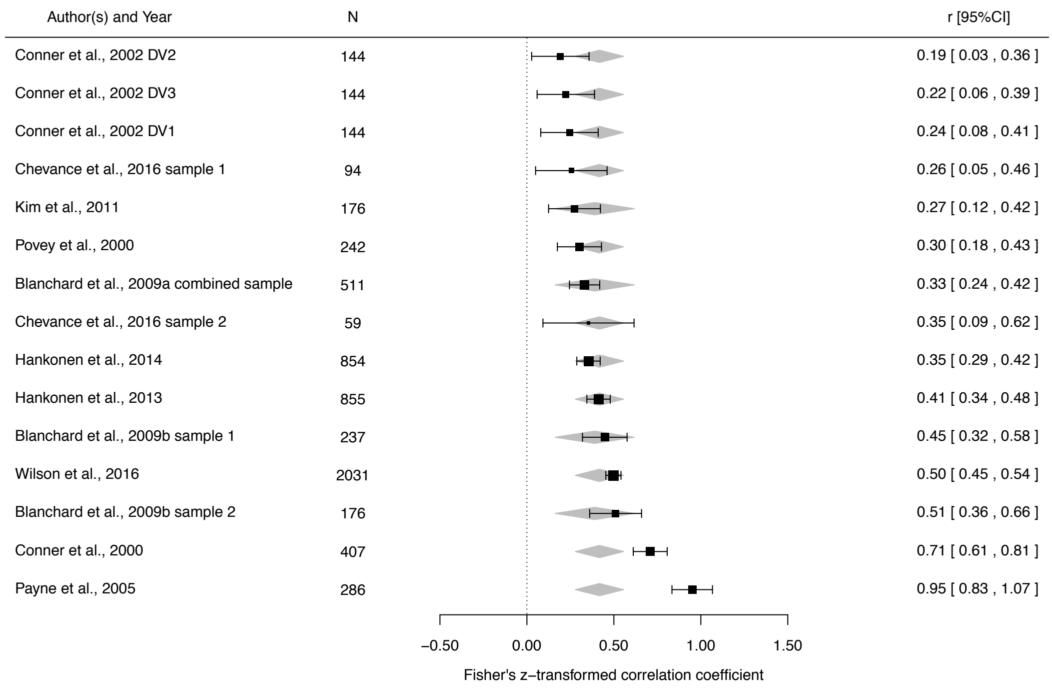

Figure 28. Fisher’s z-transformed correlations between intention and health promoting dietary moderated by employment status (employed vs. unemployed). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

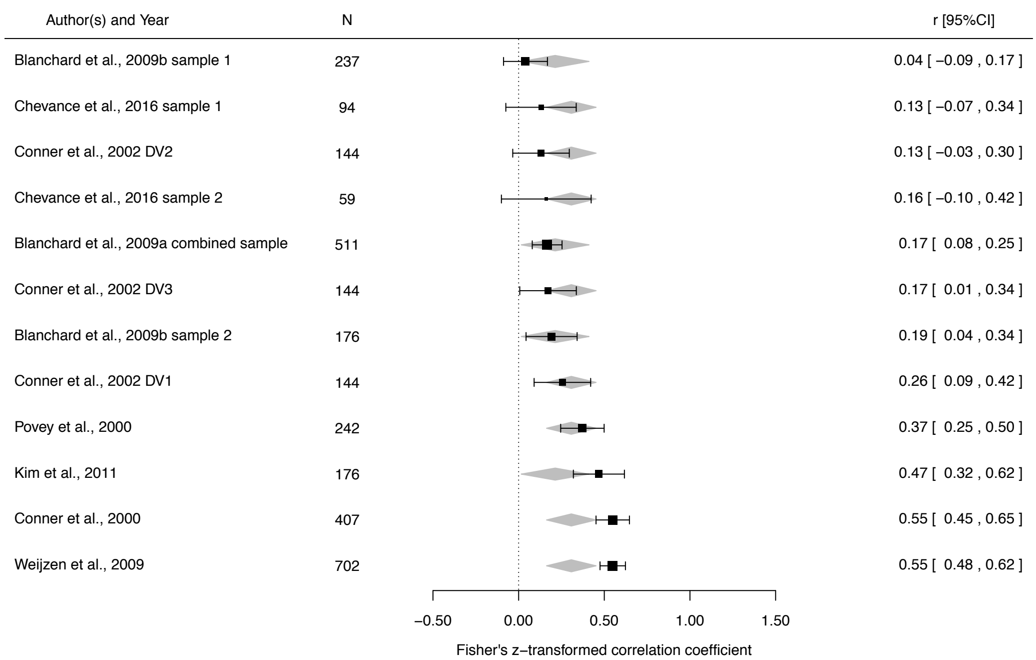

Figure 29. Fisher’s z-transformed correlations between attitude and health promoting dietary moderated by employment status (employed vs. unemployed). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

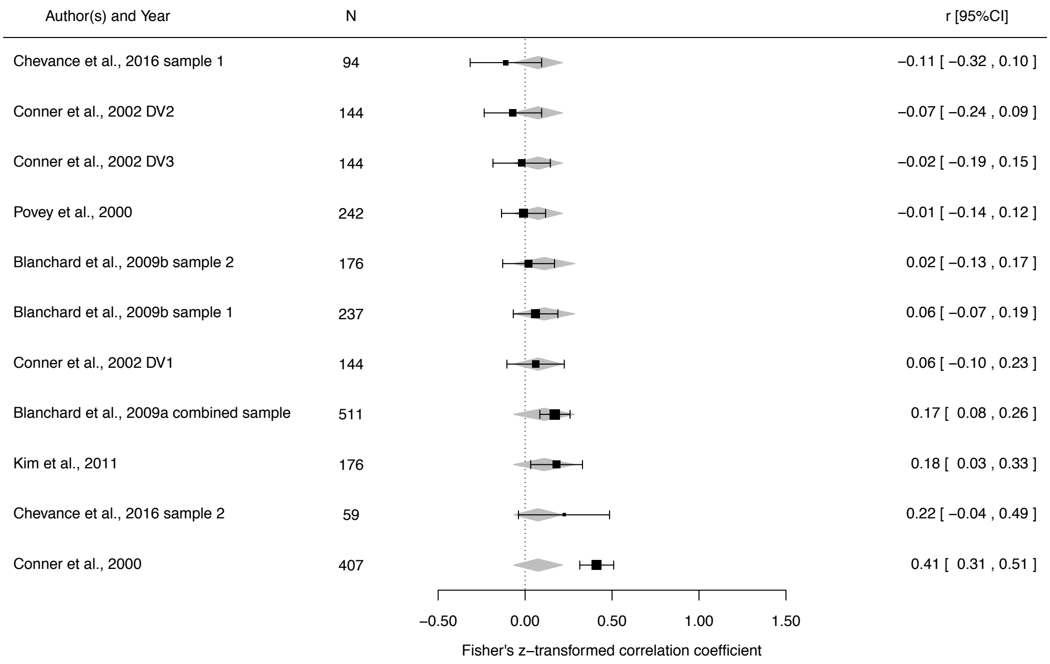

Figure 30. Fisher’s z-transformed correlations between subjective norm and health promoting dietary moderated by employment status (employed vs, unemployed). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

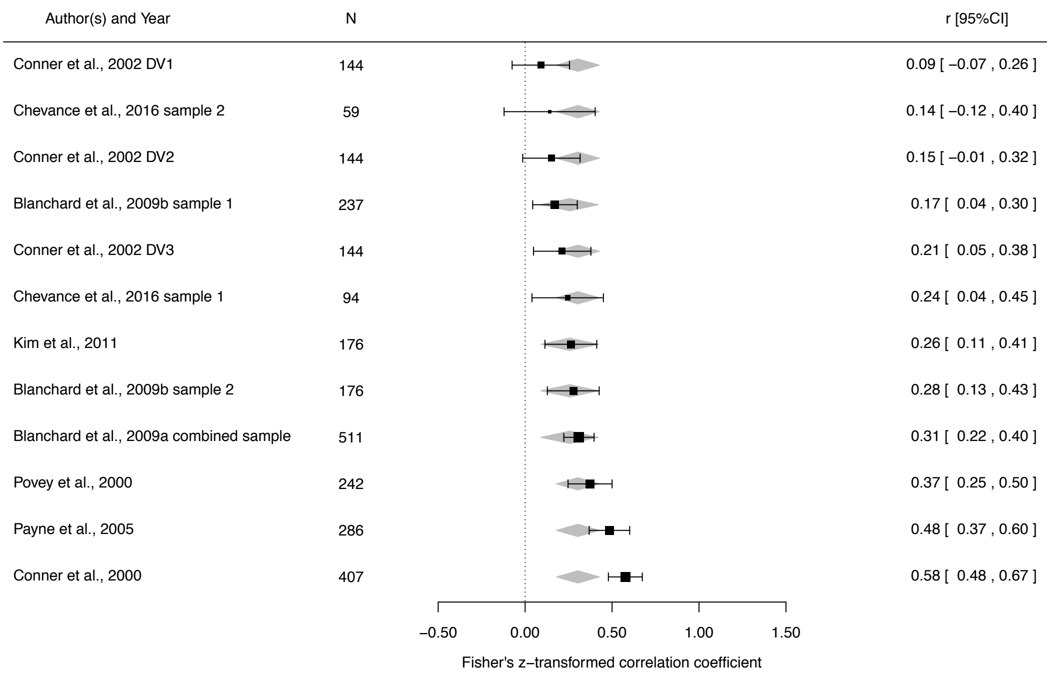

Figure 31. Fisher’s z-transformed correlations between perceived behavioural control and health promoting dietary moderated by employment status (employed vs. unemployed). Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

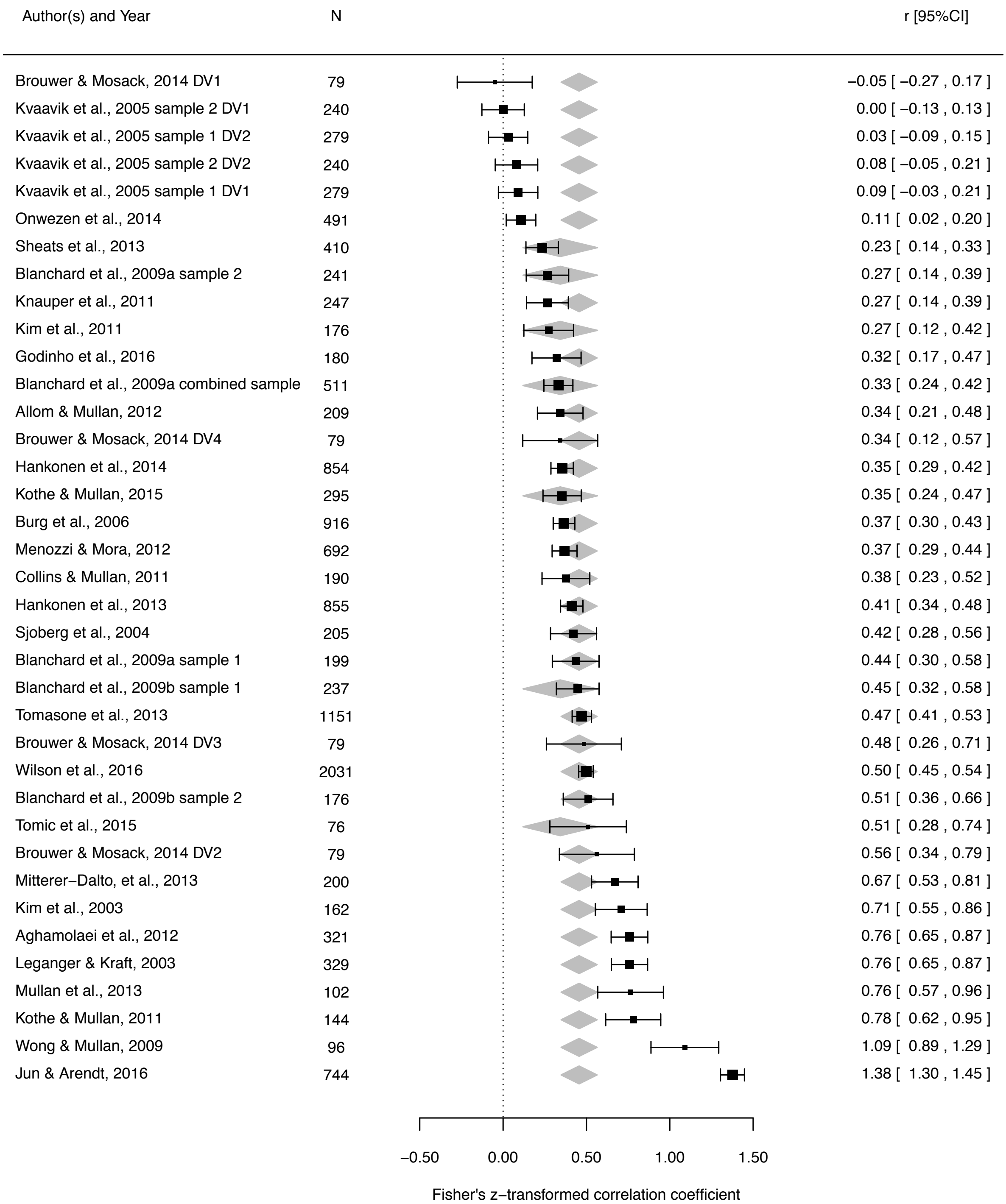

Figure 32. Fisher’s z-transformed correlations between intention and health promoting dietary moderated by race. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

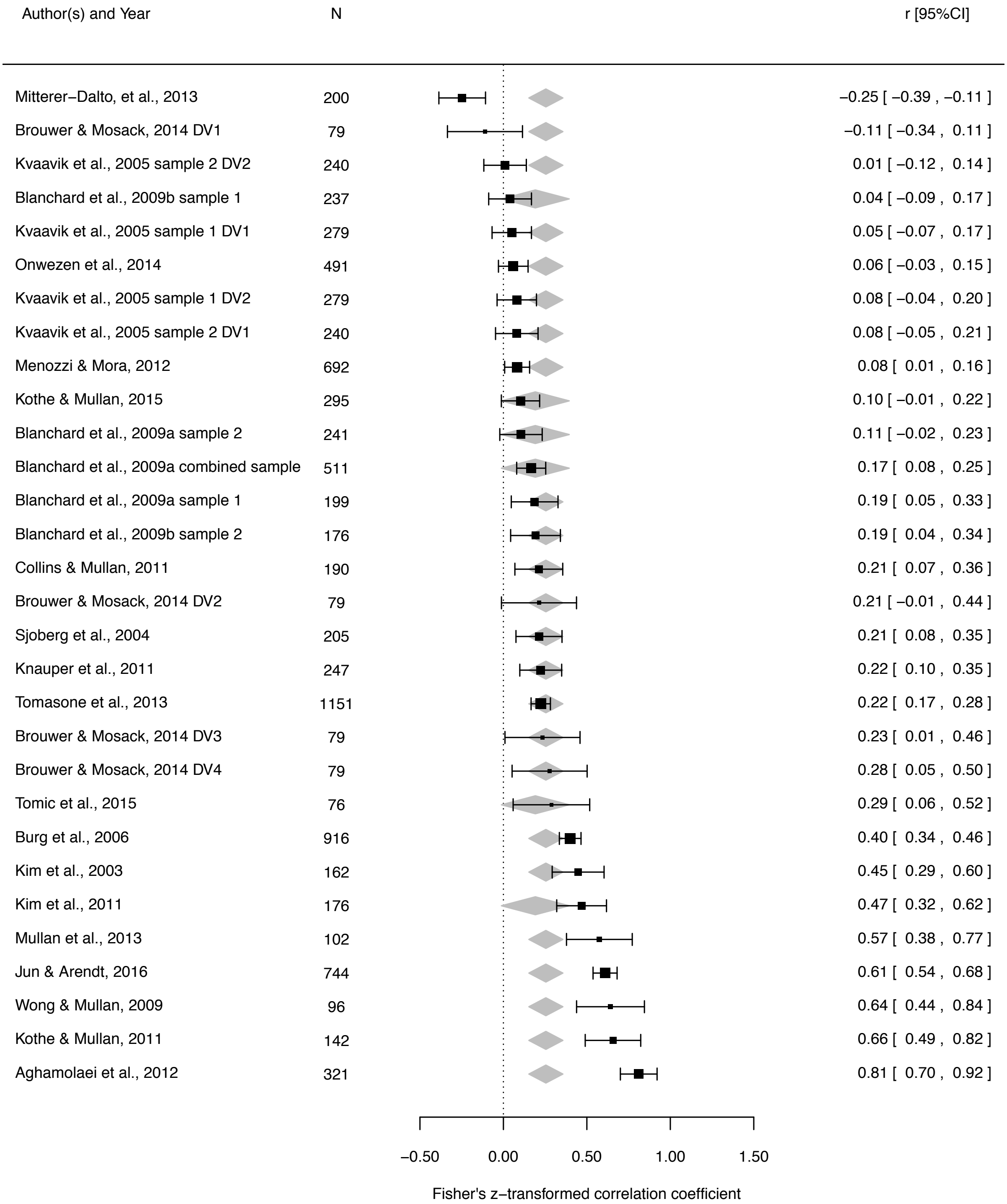

Figure 33. Fisher's z-transformed correlations between attitude and health promoting dietary moderated by race. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

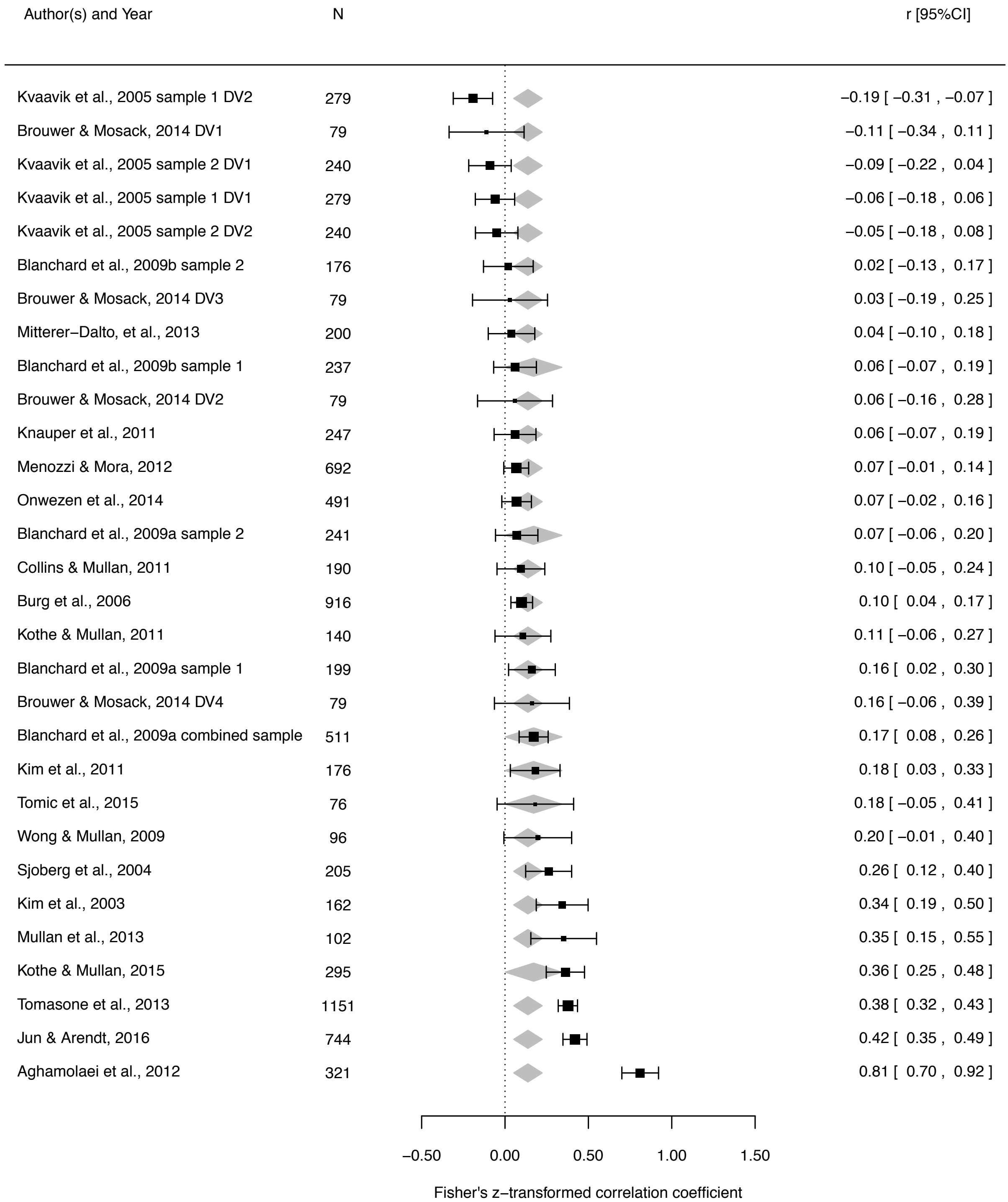

Figure 34. Fisher's z-transformed correlations between subjective norm and health promoting dietary moderated by race. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

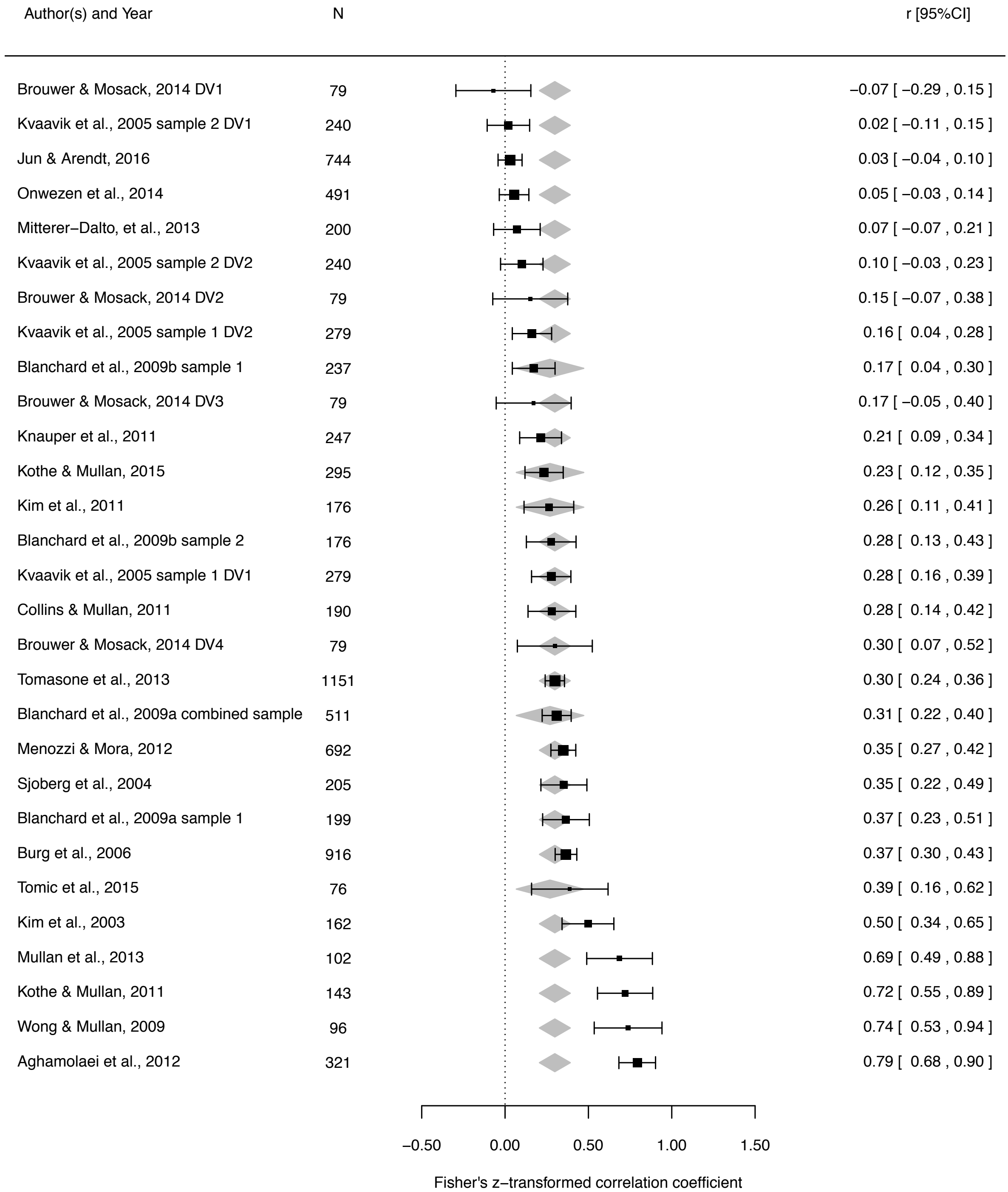

Figure 35. Fisher’s z-transformed correlations between perceived behavioural control and health promoting dietary moderated by race. Correlations (squares) and 95% confidence intervals (CI) are displayed for all effects entered into the meta-analysis. The grey diamond represents the meta-analytically estimated correlation. *N* refers to the sample size of studies.

Appendix F

Funnel Plots

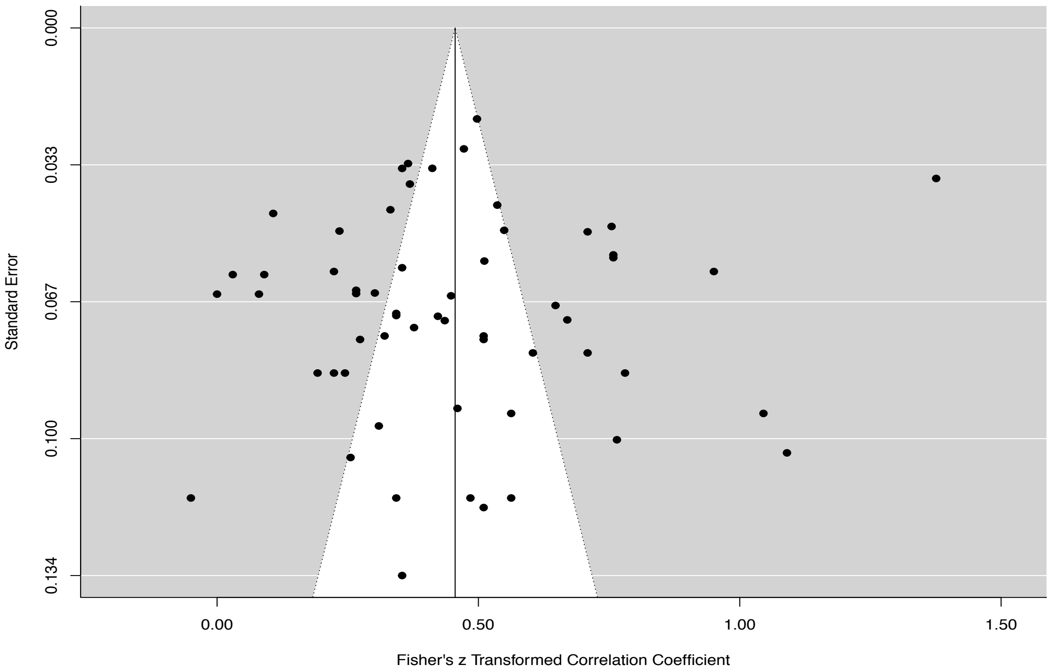

Figure 36. Funnel plot for intention and health promoting dietary behaviour

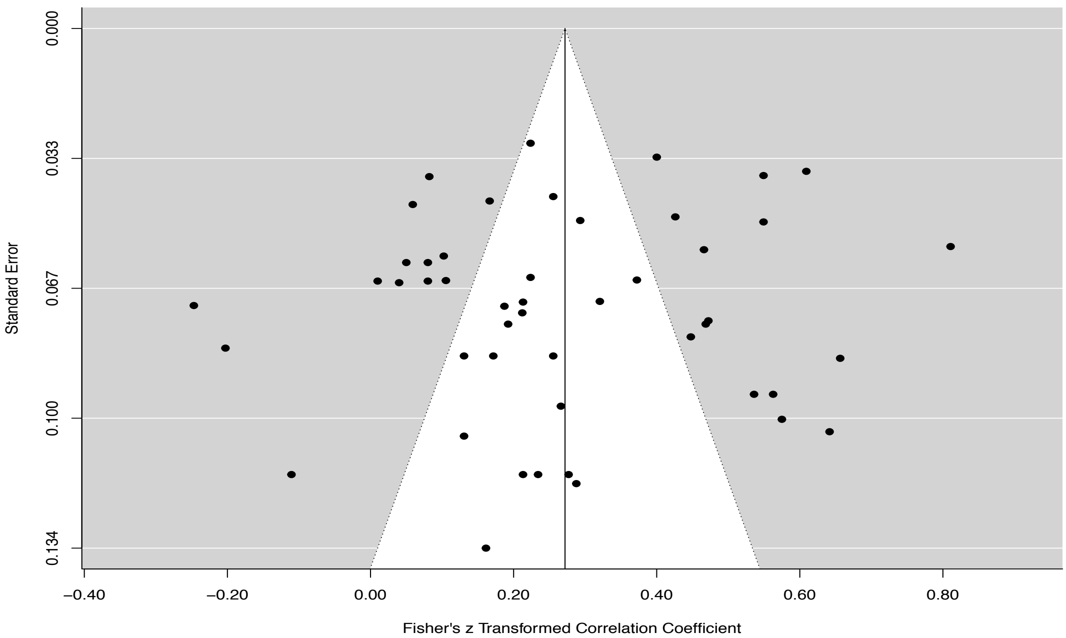

Figure 37. Funnel plot for attitude and health promoting dietary behaviour

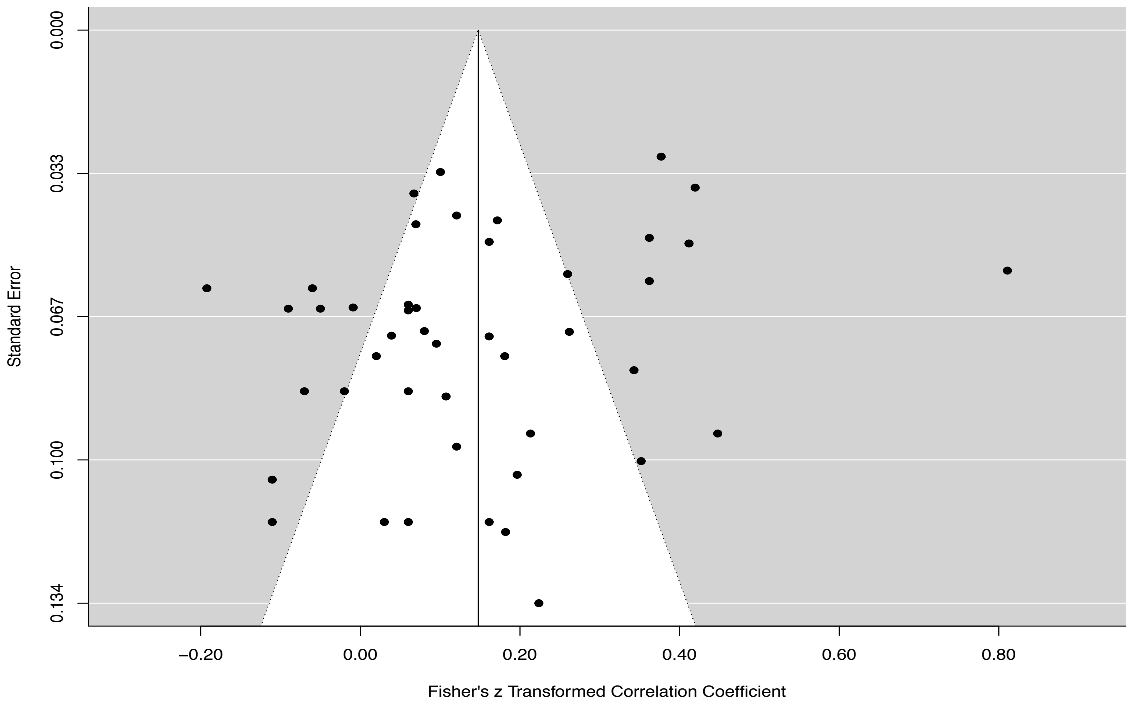

Figure 38. Funnel plot for subjective norm and health promoting dietary behaviour

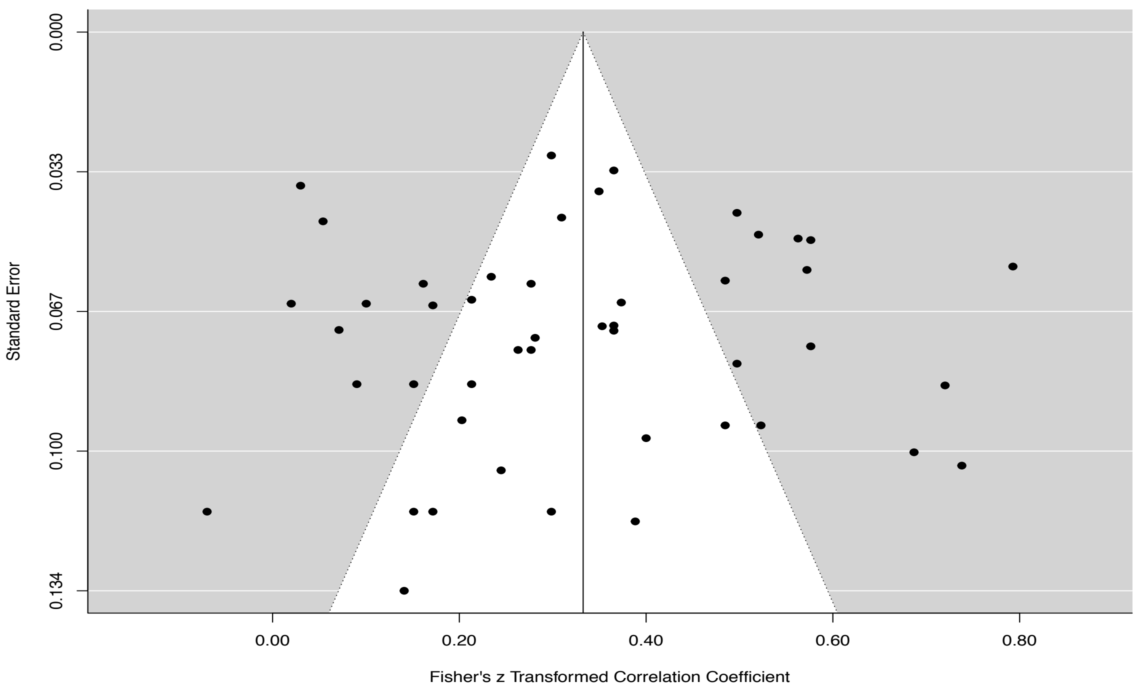

Figure 39. Funnel plot for perceived behavioural control and health promoting dietary behaviour

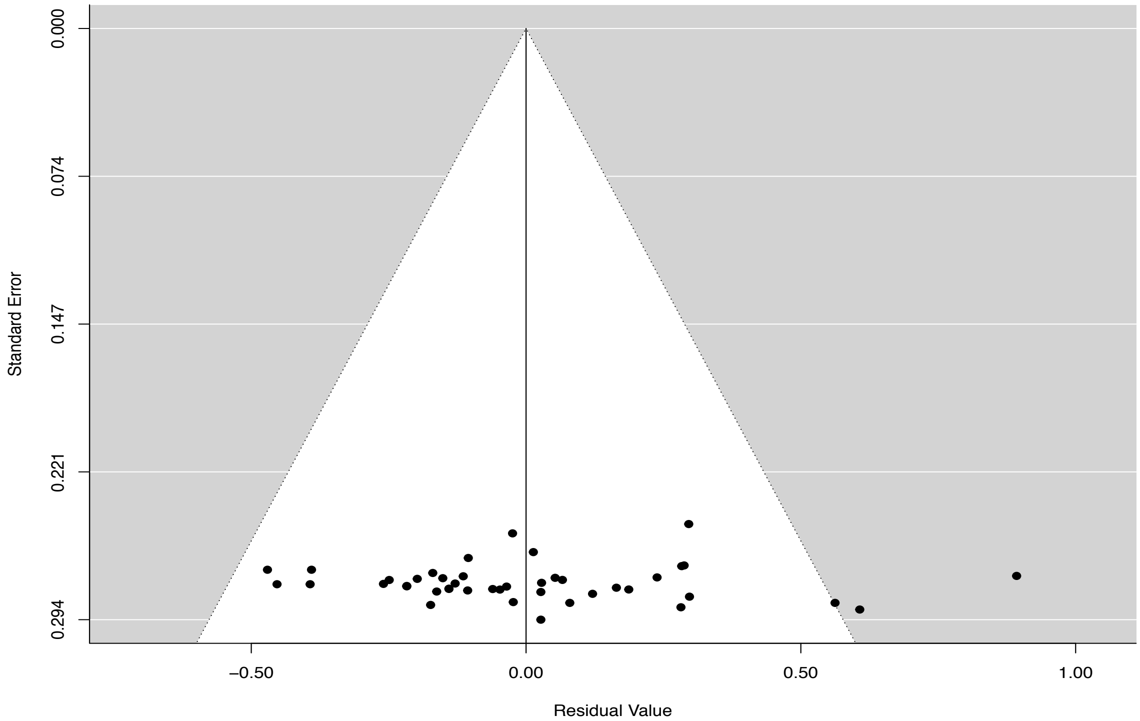

Figure 40. Funnel plot for intention-behaviour moderated by education

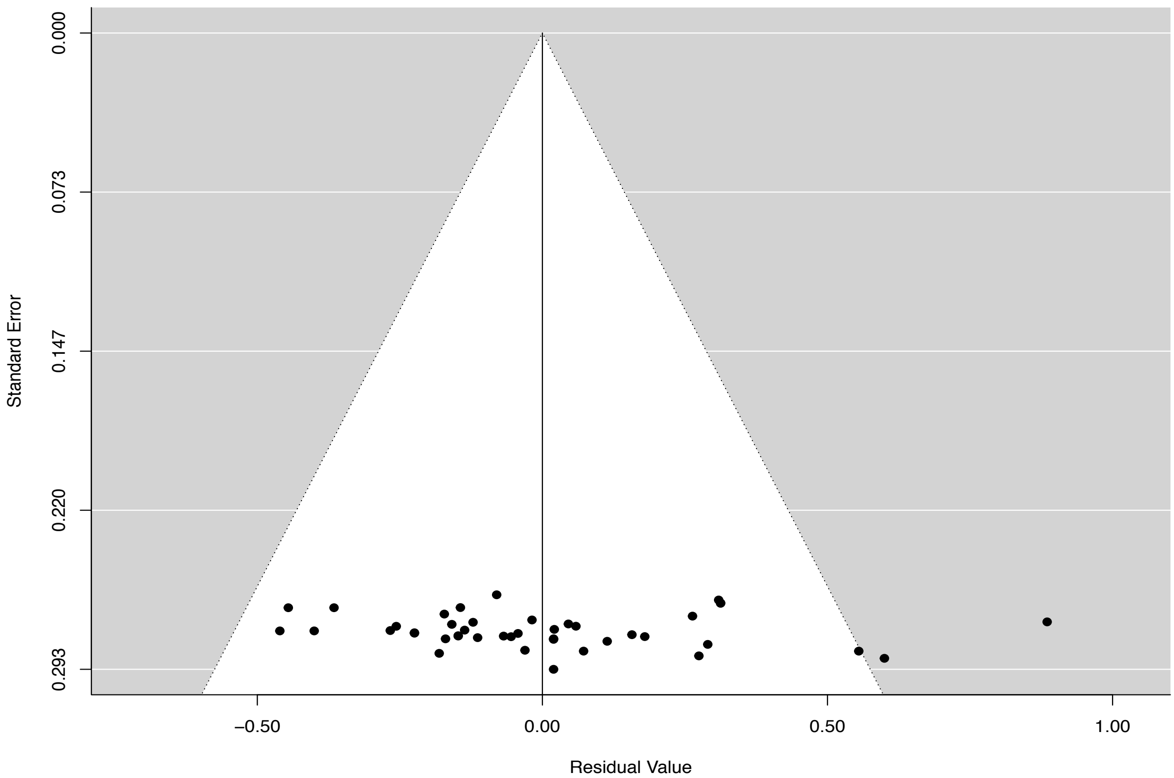

Figure 41. Funnel plot for intention-behaviour education median split

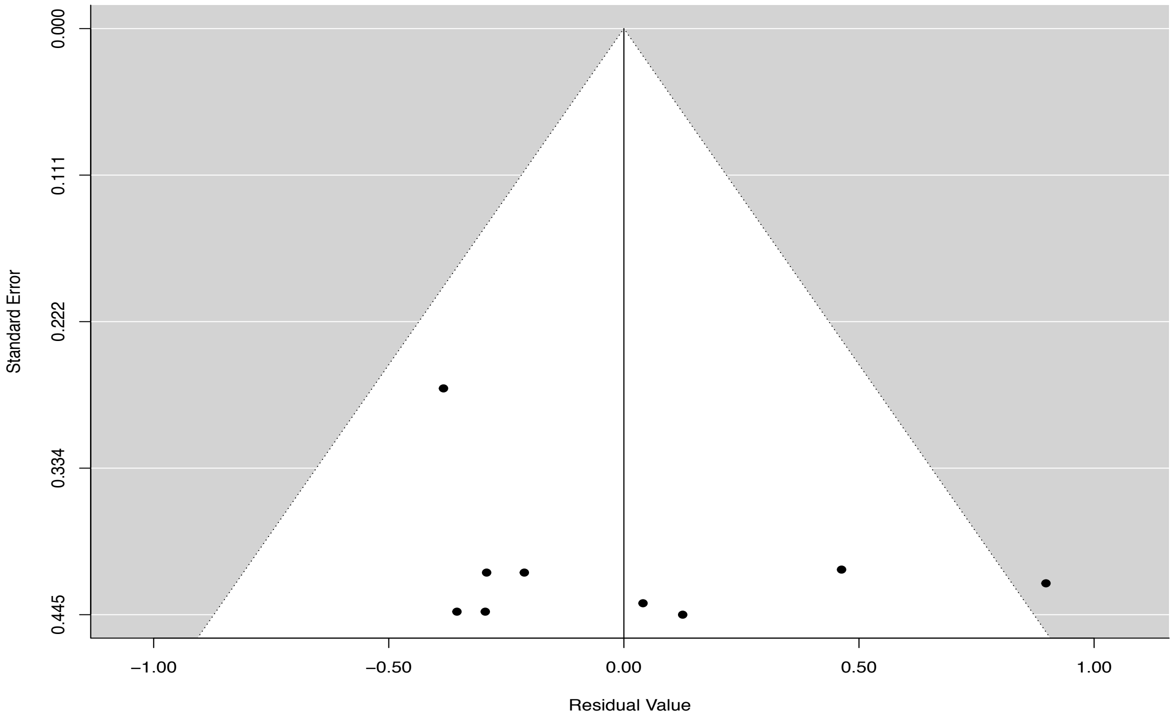

Figure 42. Funnel plot for intention-behaviour moderated by income

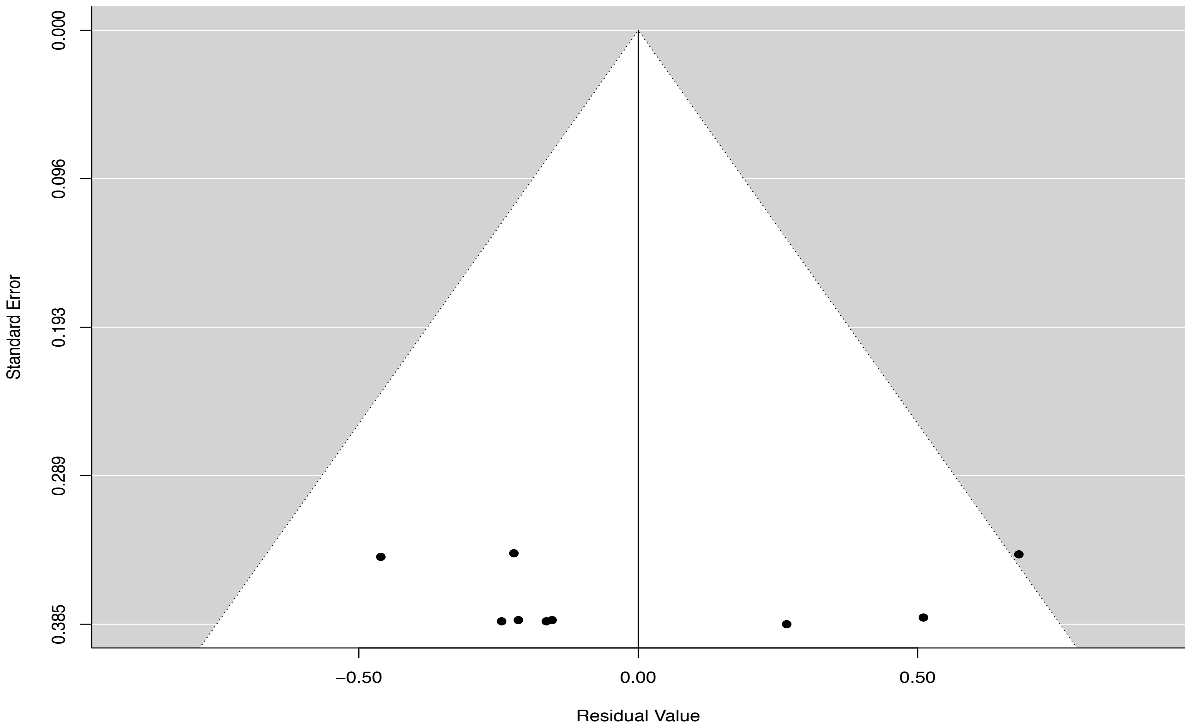

Figure 43. Funnel plot for intention-behaviour moderated by income median split

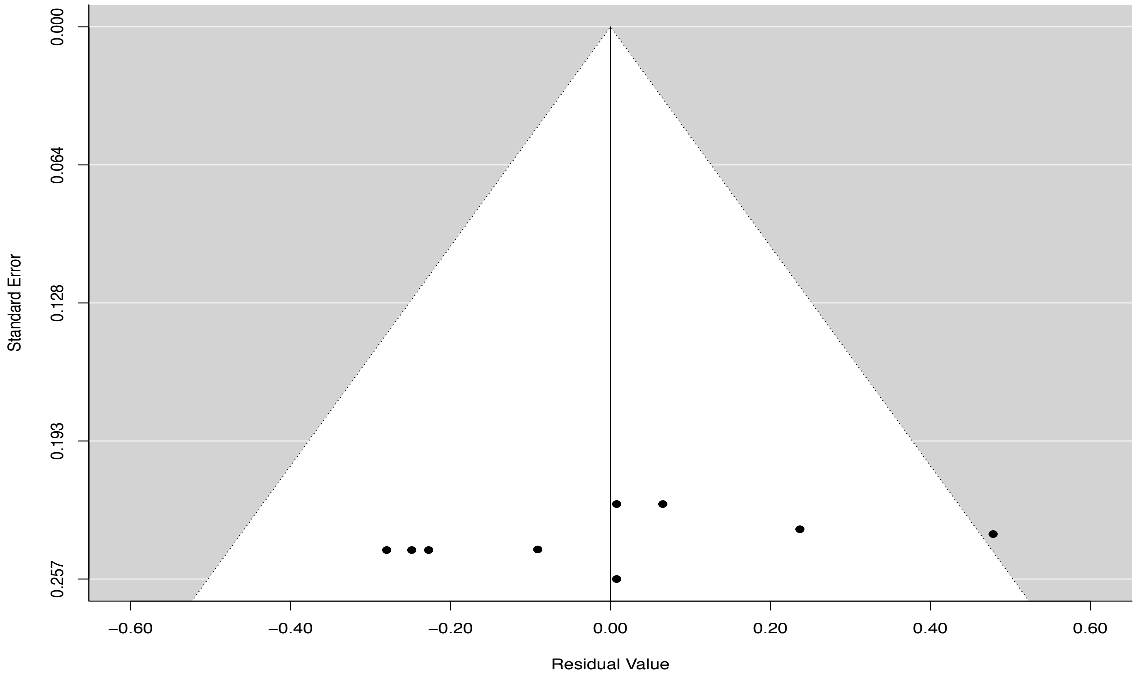

Figure 44. Funnel plot for intention-behaviour moderated by occupation blue vs. white

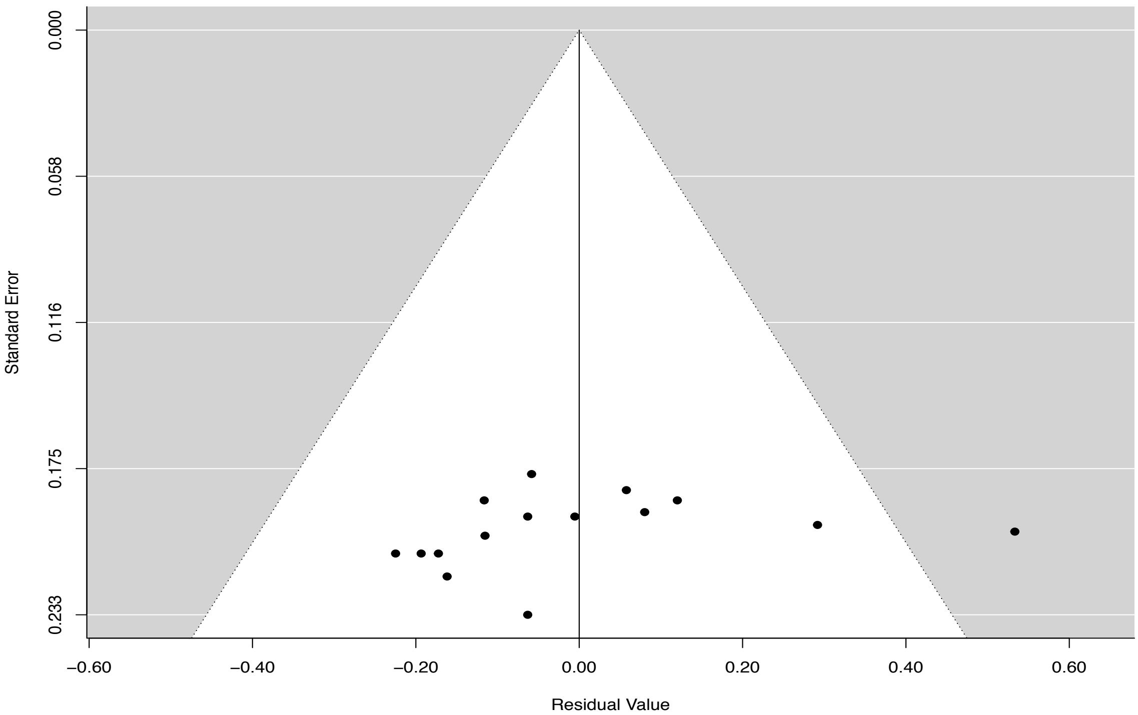

Figure 45. Funnel plot for intention-behaviour moderated by occupation employed vs. unemployed

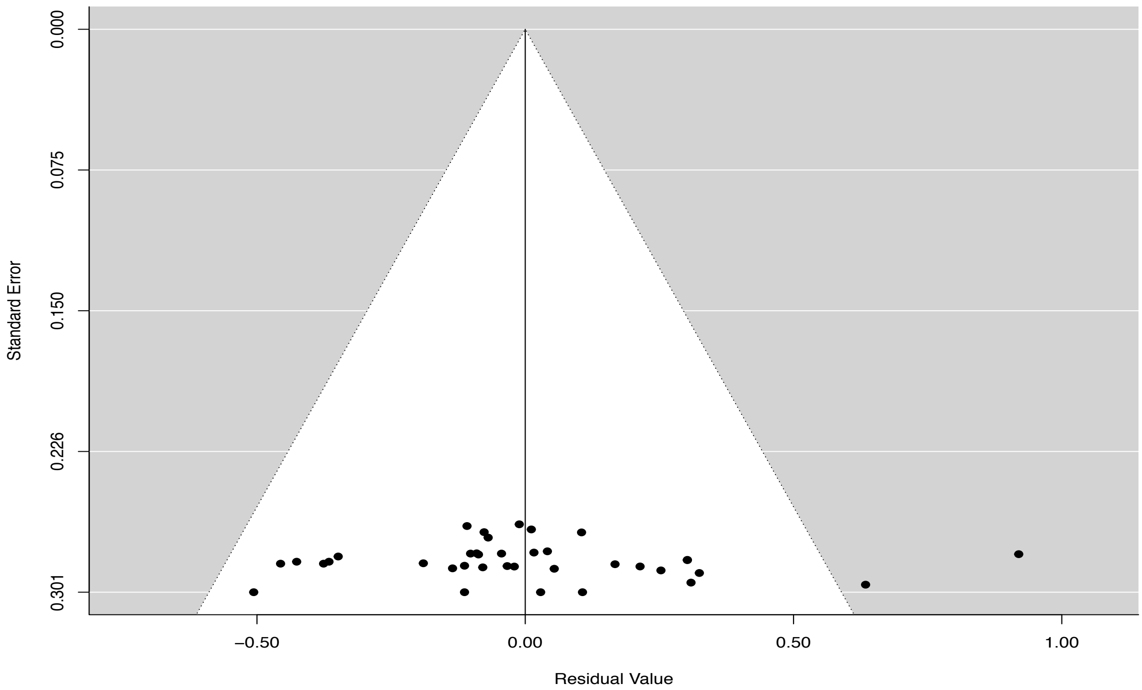

Figure 46. Funnel plot for intention-behaviour moderated by race

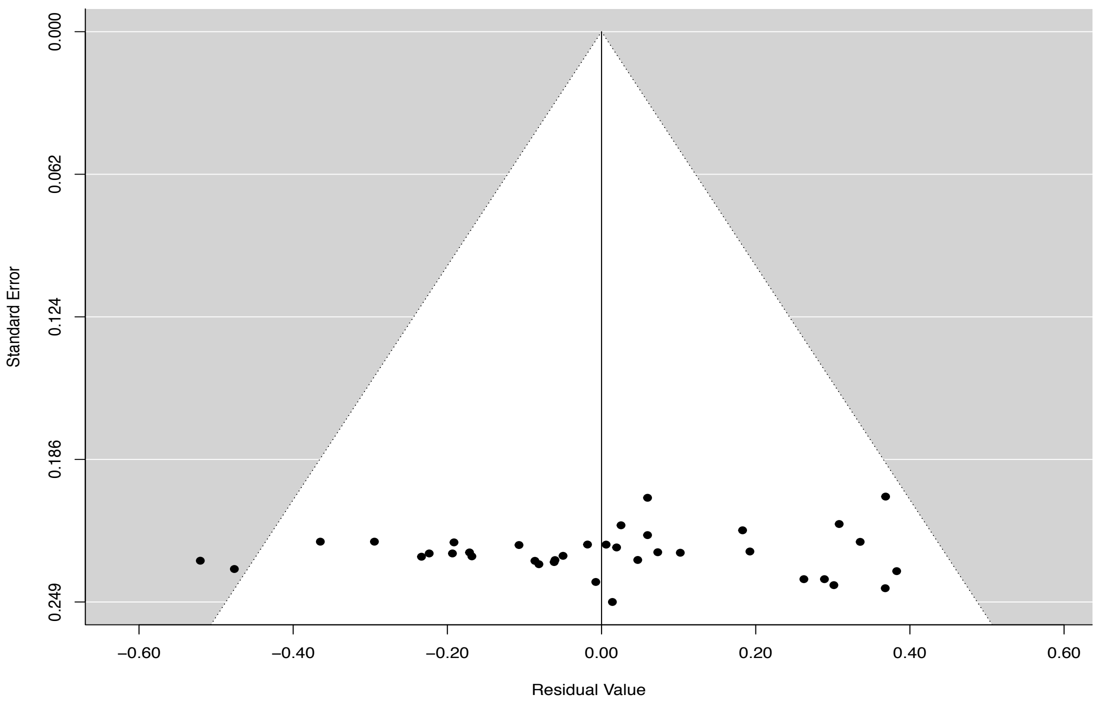

Figure 47. Funnel plot for attitude-behaviour moderated by education

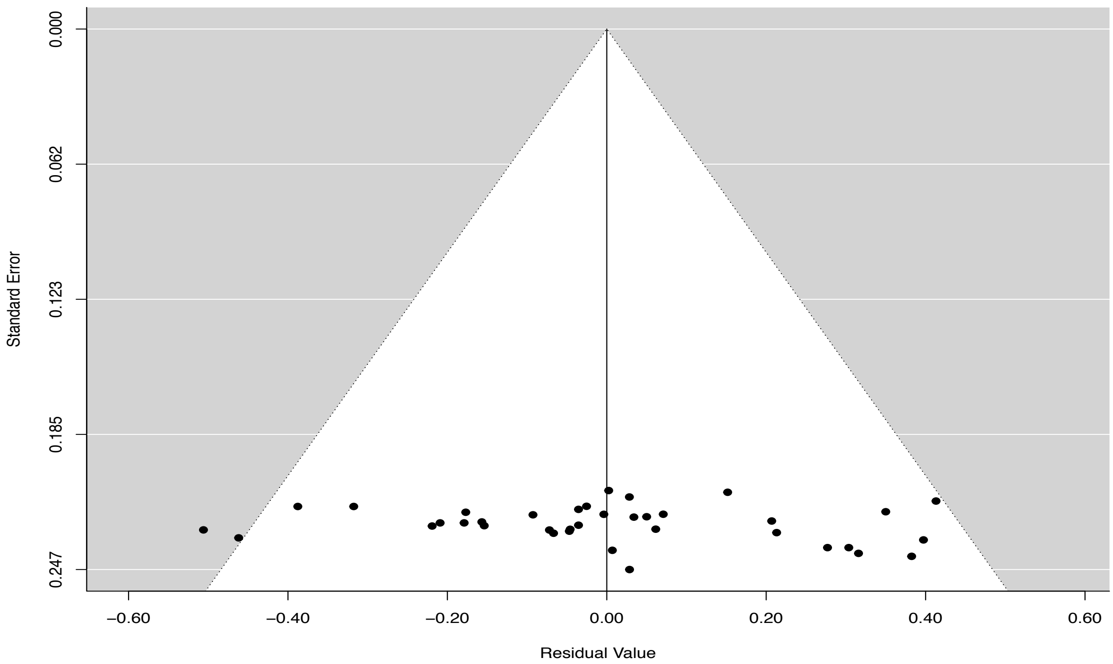

Figure 48. Funnel plot for attitude-behaviour moderated by education median split

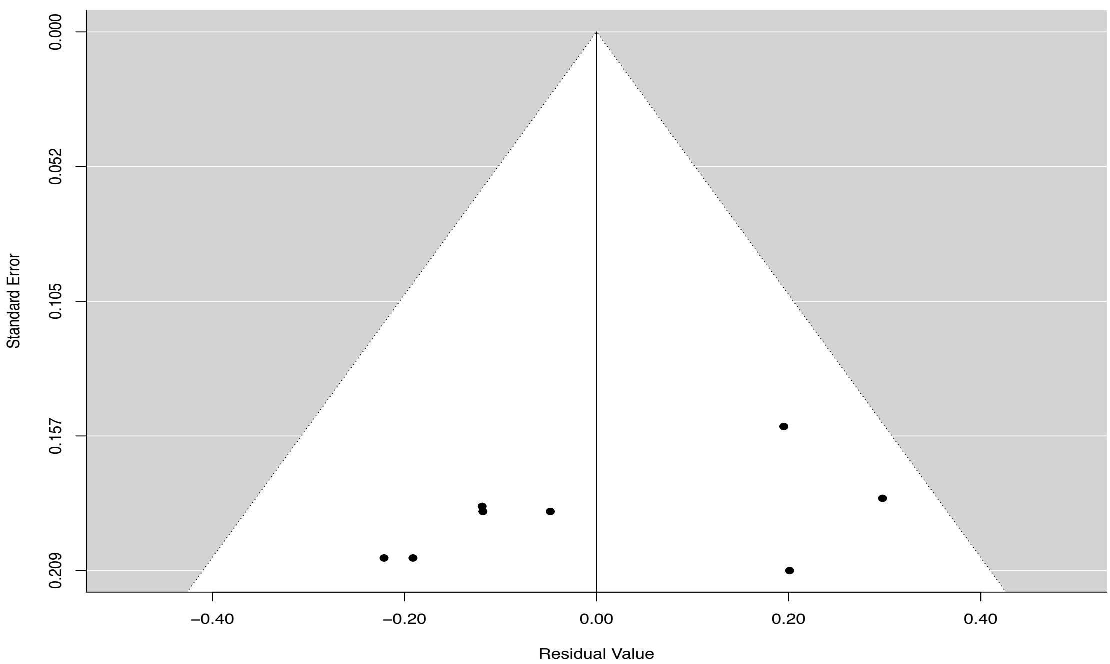

Figure 49. Funnel plot for attitude-behaviour moderated by income

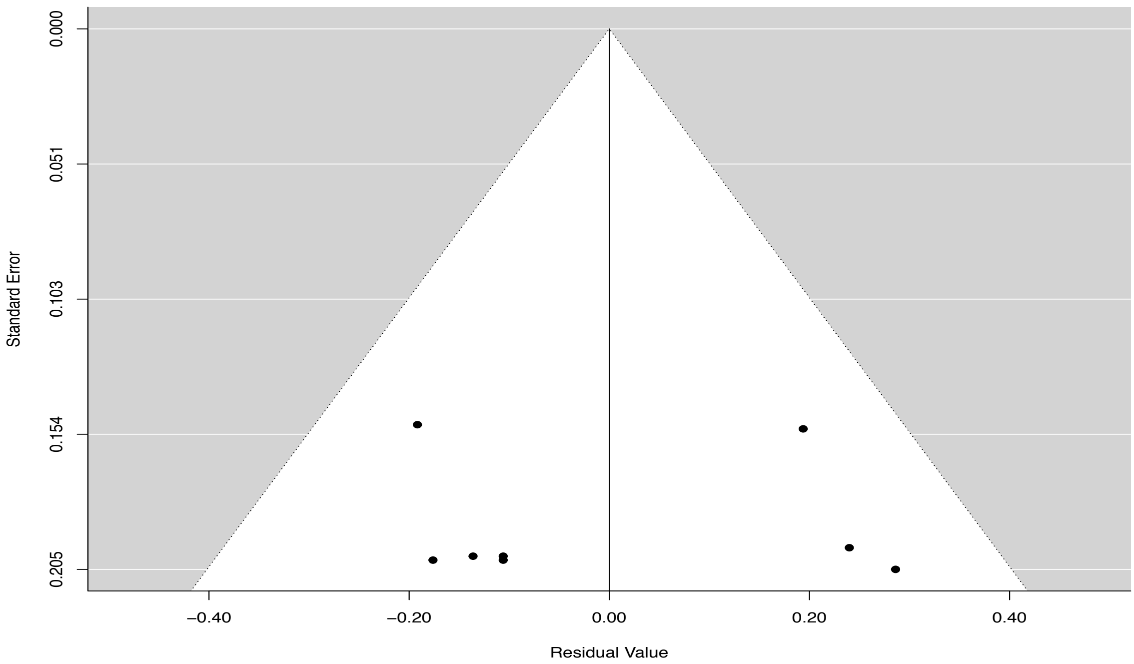

Figure 50. Funnel plot for attitude-behaviour moderated by income median split

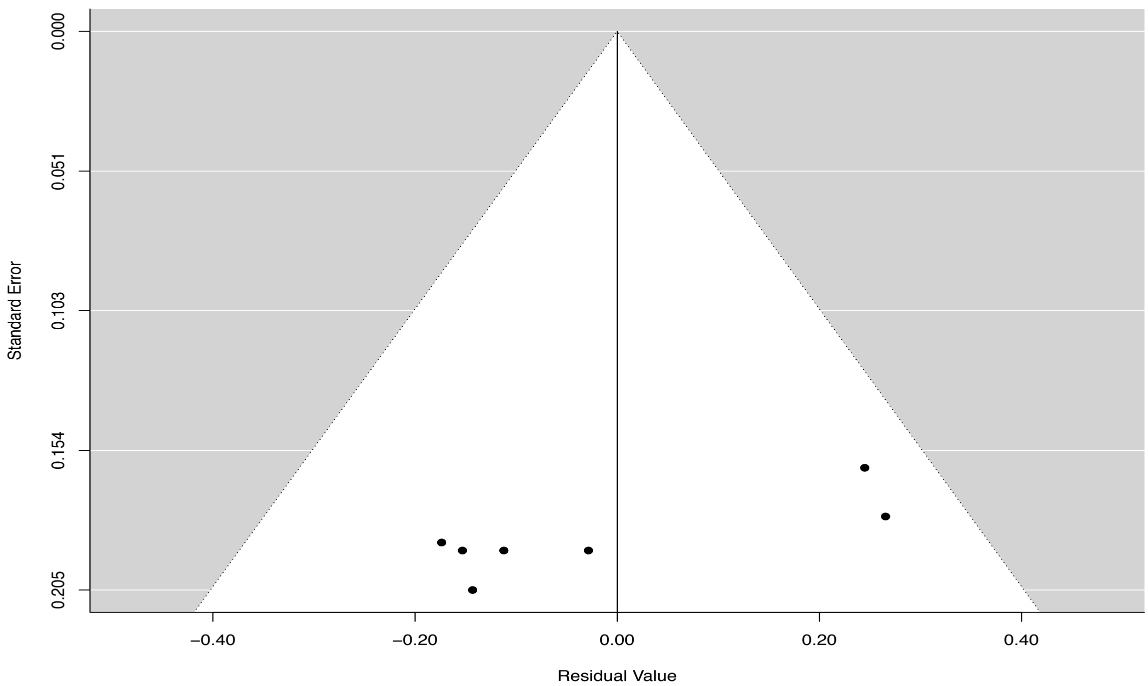

Figure 51. Funnel plot for attitude-behaviour moderated by occupation blue vs. white

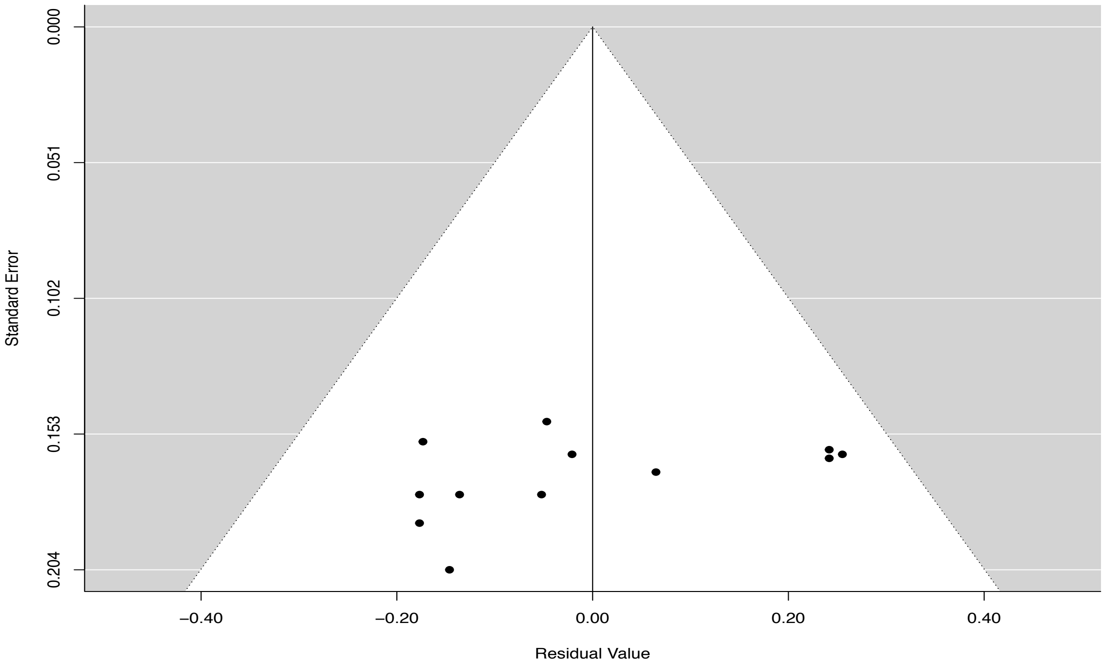

Figure 52. Funnel plot for attitude-behaviour moderated by occupation employed vs. unemployed

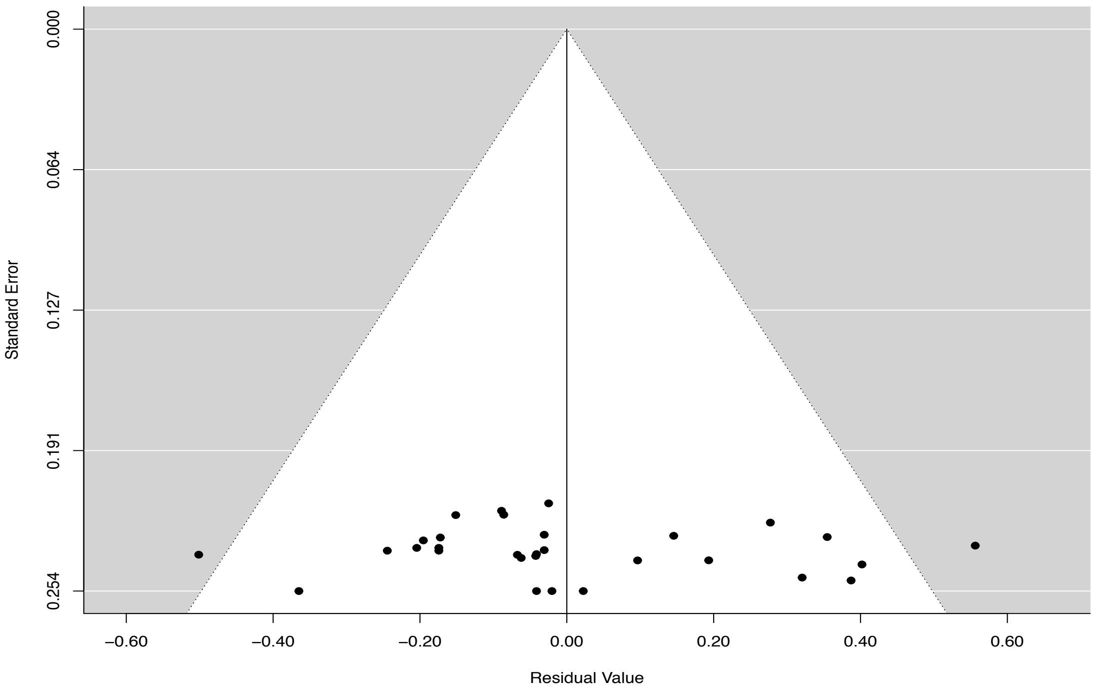

Figure 53. Funnel plot for attitude-behaviour moderated by race

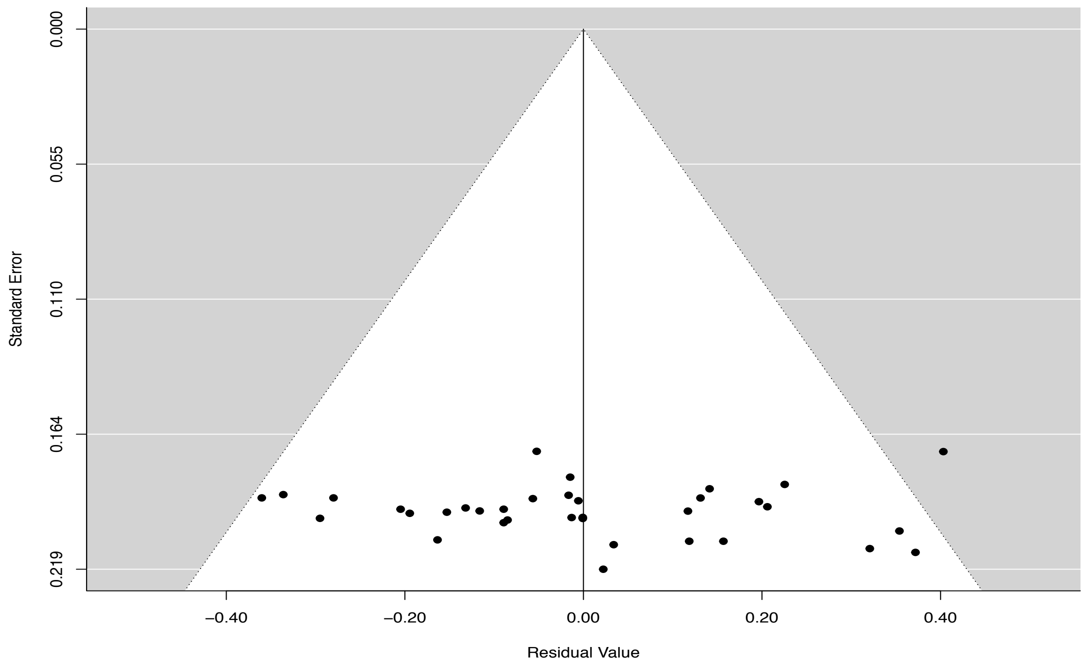

Figure 54, Funnel plot for perceived behavioural control-behaviour moderated by education

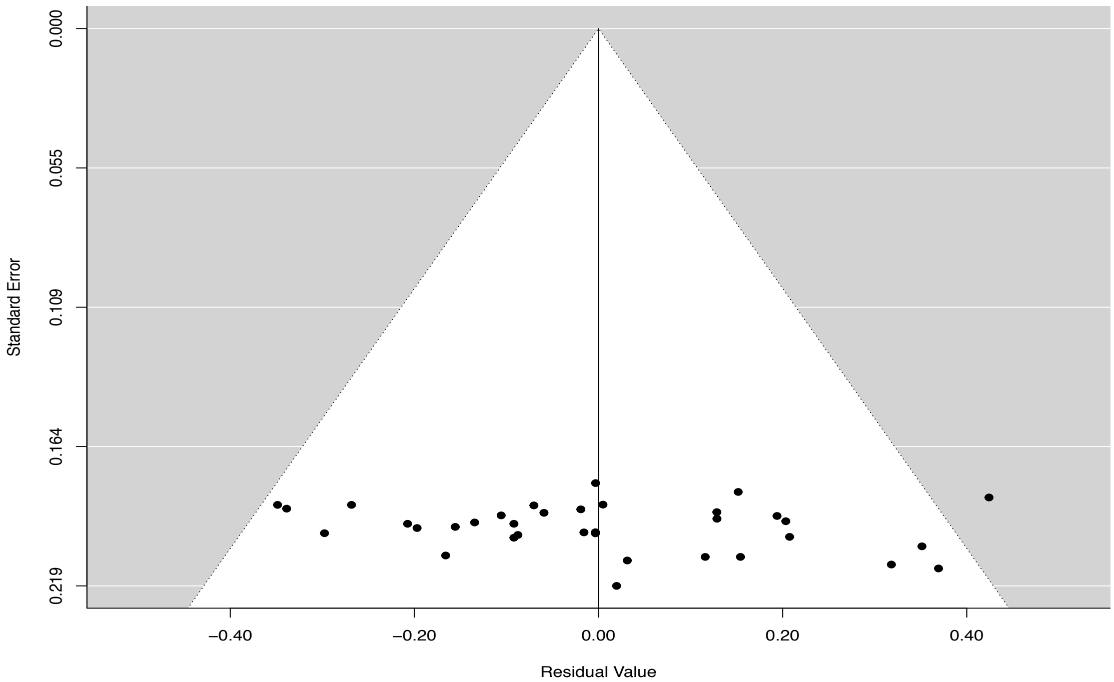

Figure 55. Funnel plot for perceived behavioural control-behaviour education median split

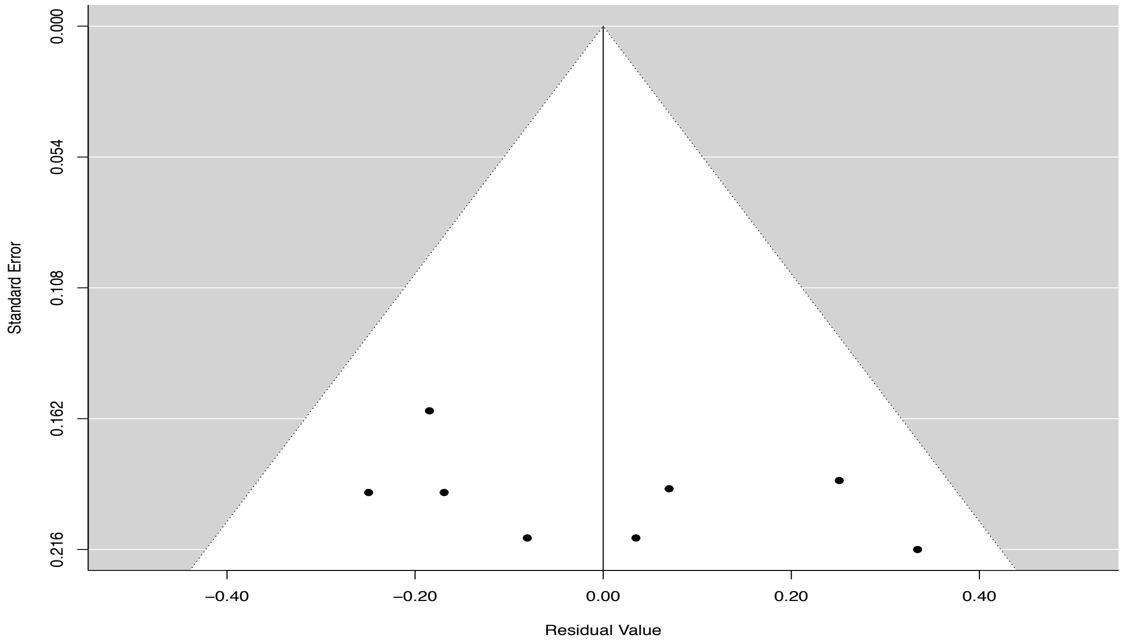

Figure 56. Funnel plot for perceived behavioural control-behaviour moderated by income

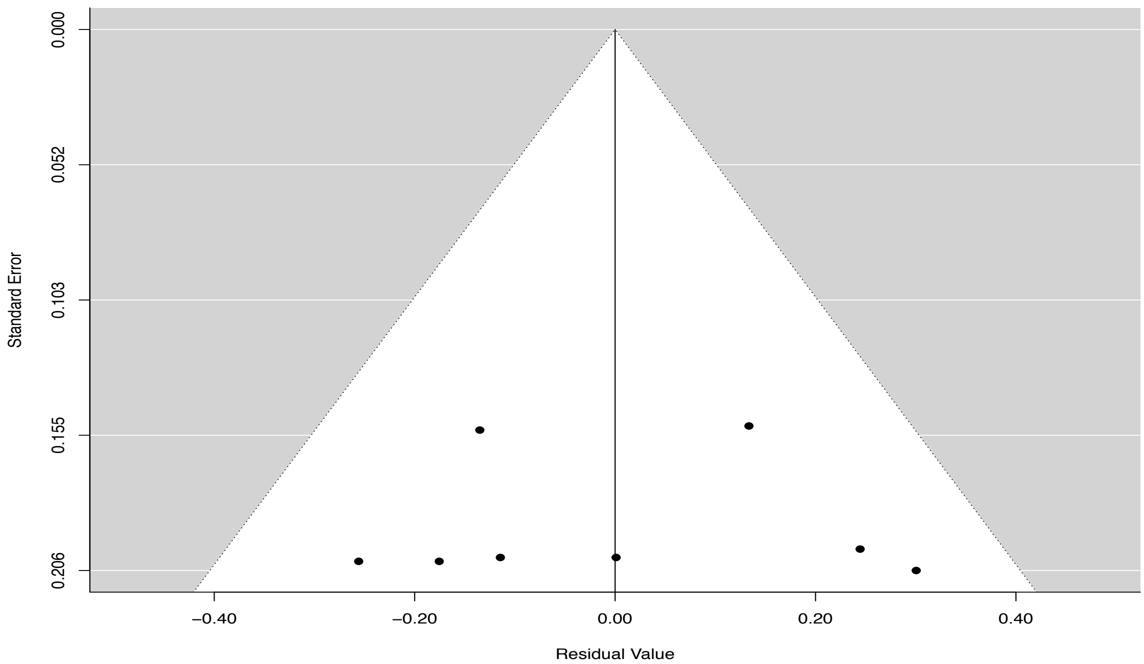

Figure 57. Funnel plot for perceived behavioural control-behaviour moderated by income median split

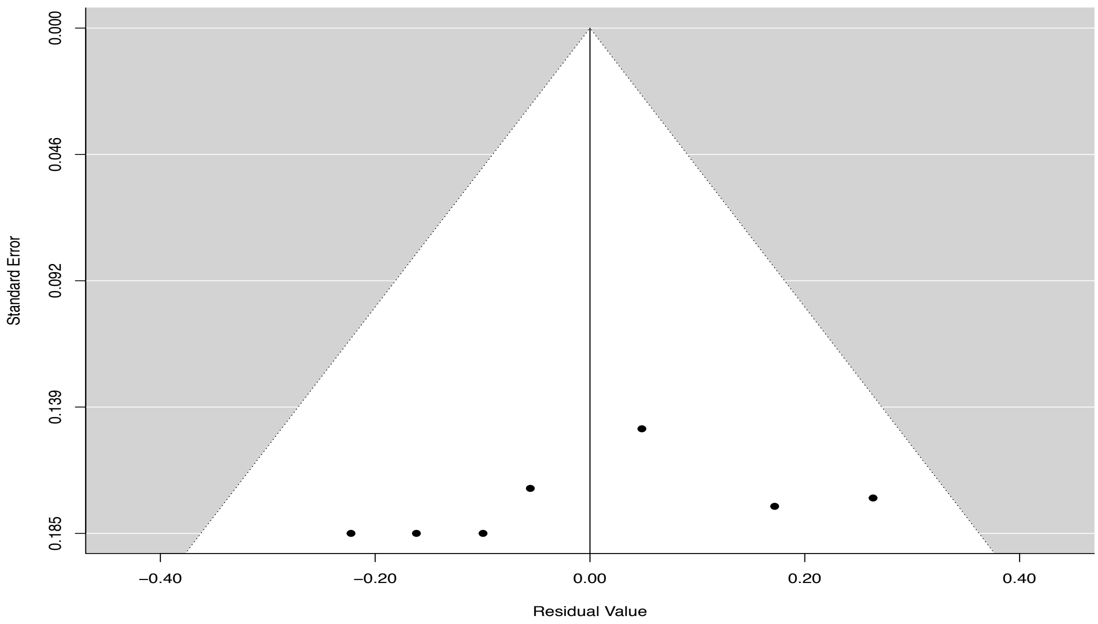

Figure 58. Funnel plot for perceived behavioural control-behaviour moderated by occupation blue vs. white

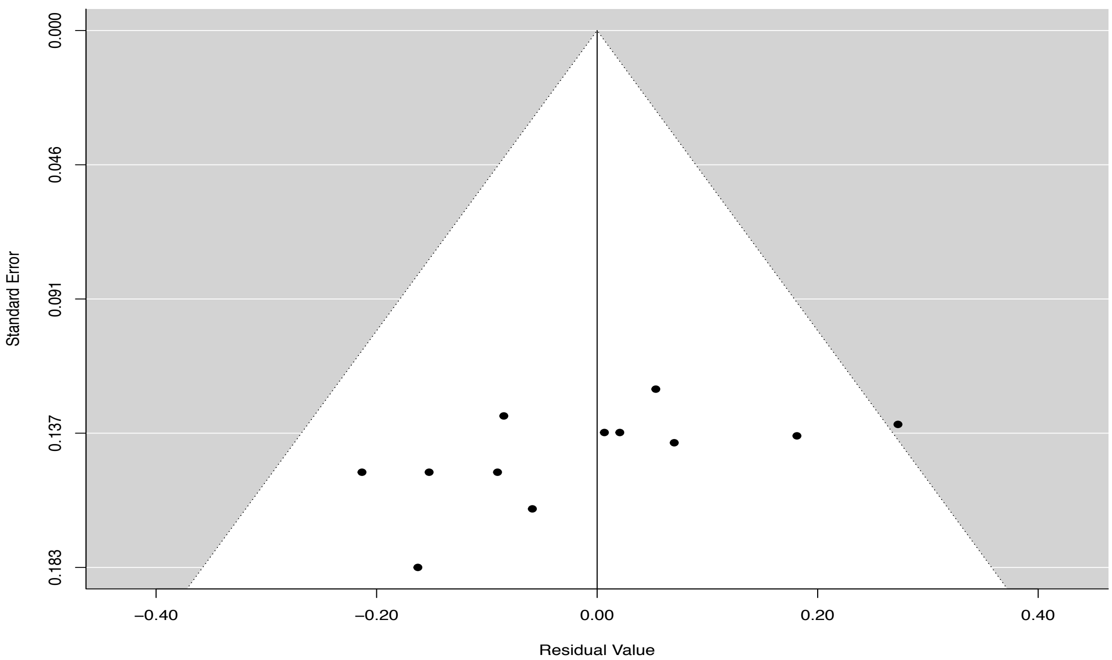

Figure 59. Funnel plot for perceived behavioural control-behaviour moderated by occupation employed vs. unemployed

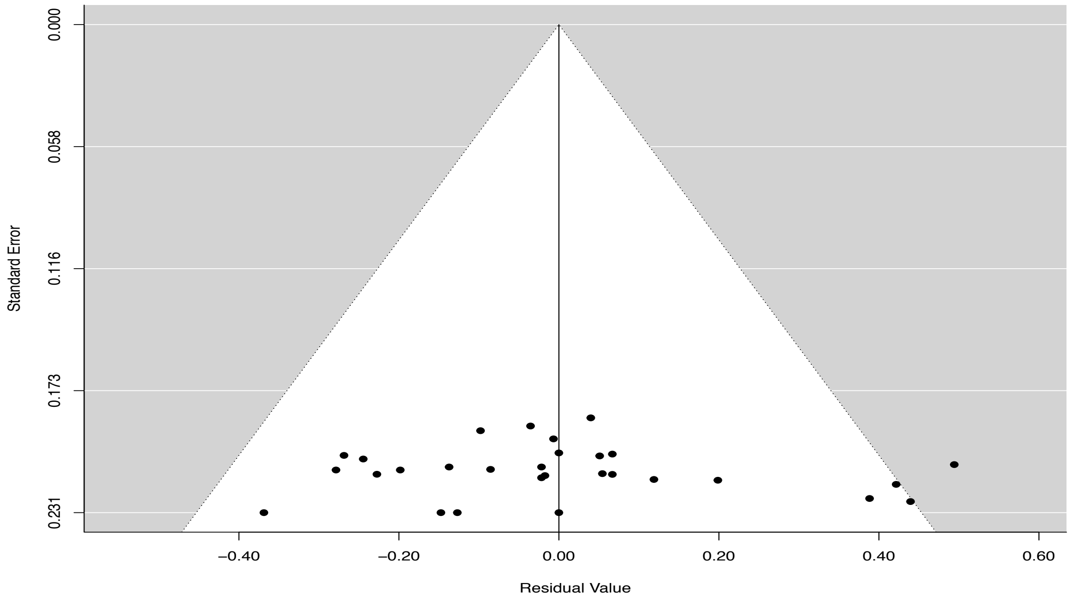

Figure 60. Funnel plot for perceived behavioural control-behaviour moderated by race

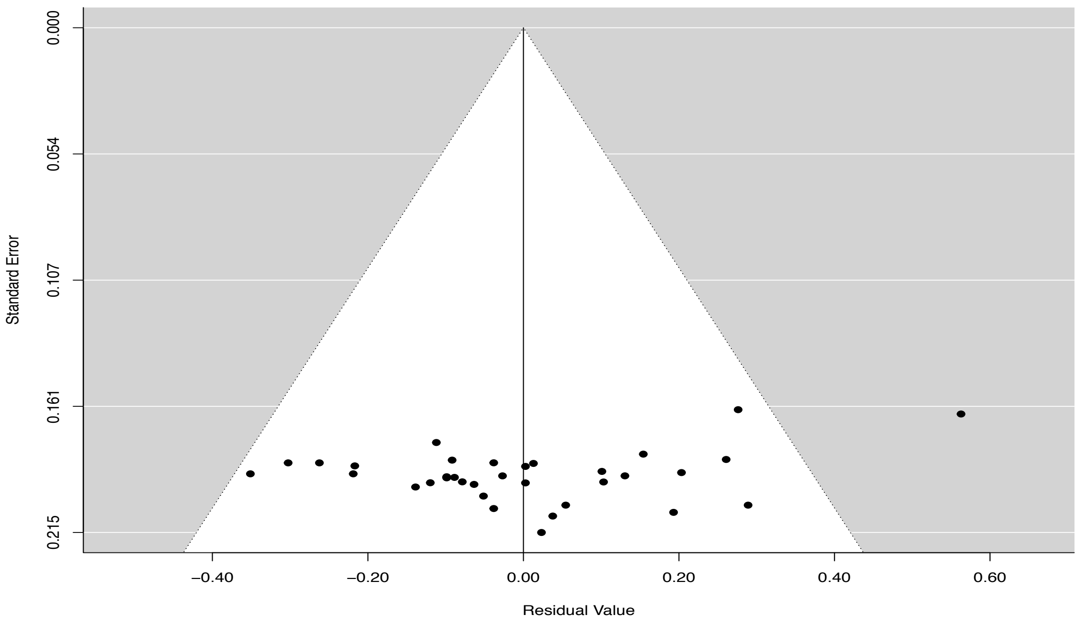

Figure 61. Funnel plot for subjective norm-behaviour moderated by education

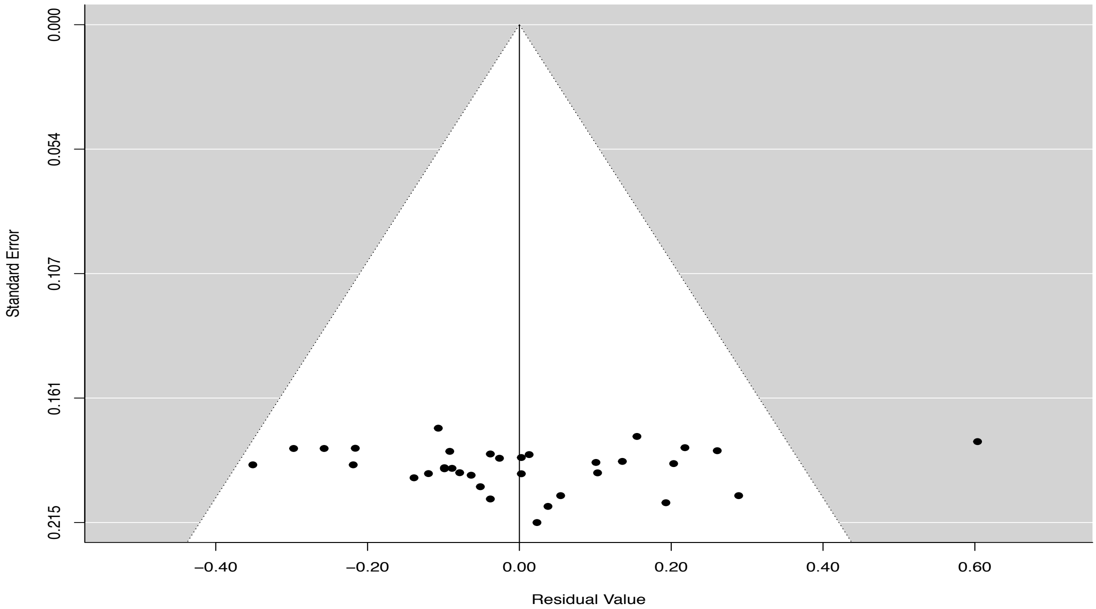

Figure 62. Funnel plot for subjective norm-behaviour moderated by education median split

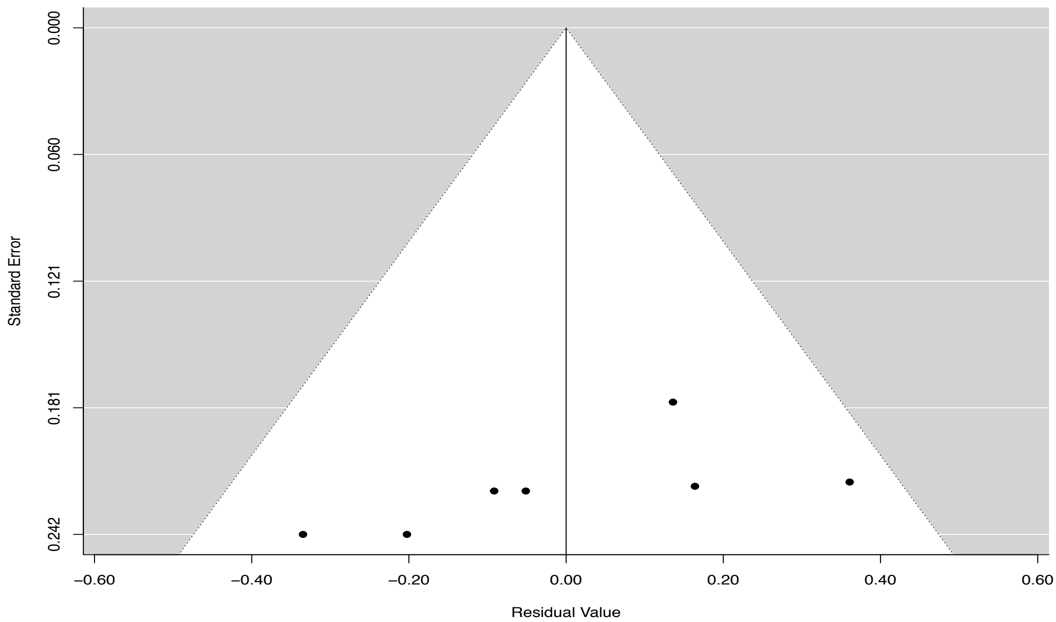

Figure 63. Funnel plot for subjective norm-behaviour moderated by income

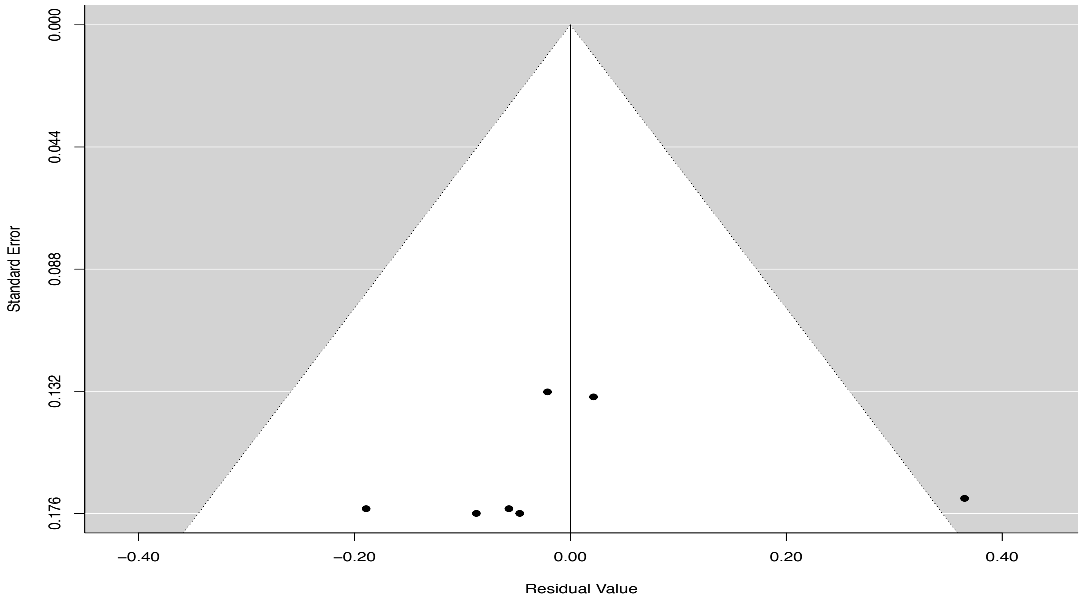

Figure 64. Funnel plot for subjective norm-behaviour moderated by income median split

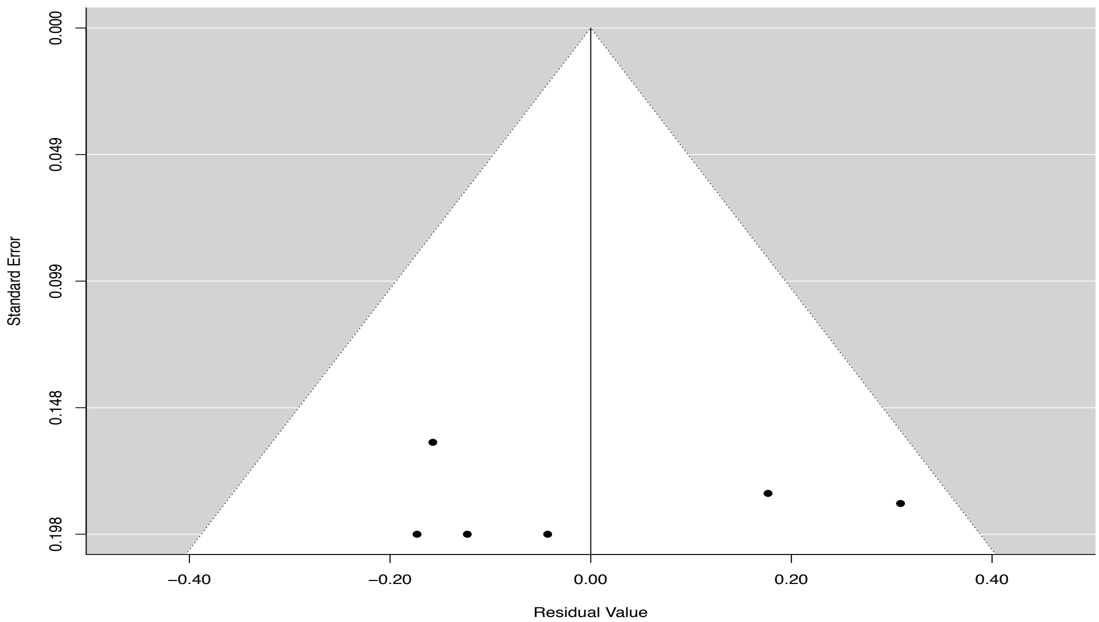

Figure 65. Funnel plot for subjective norm-behaviour moderated by occupation blue vs. white

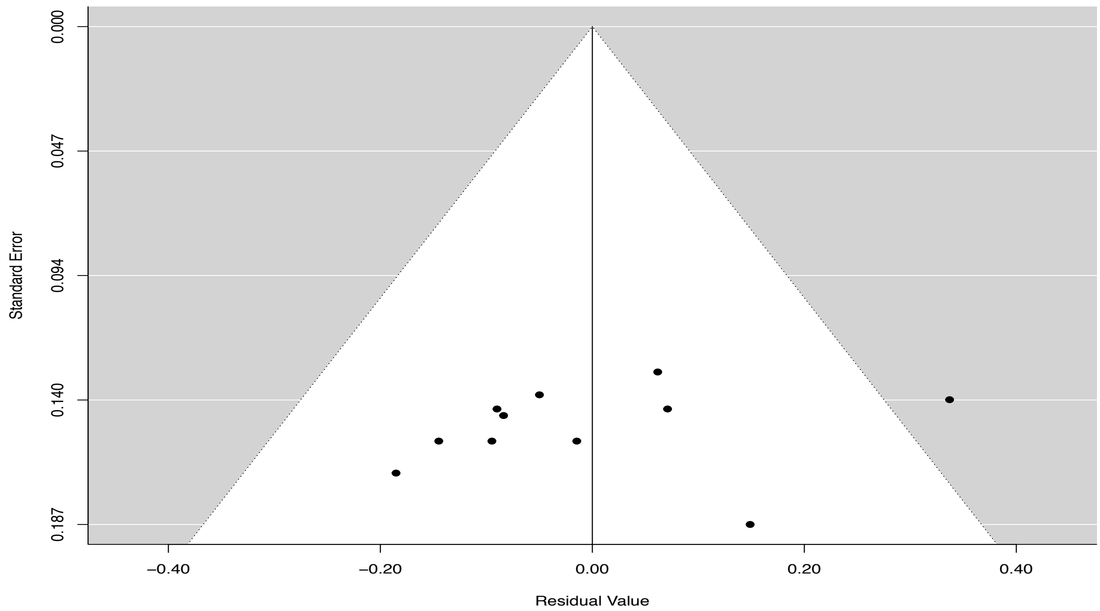

Figure 66. Funnel plot for subjective norm-behaviour moderated by occupation employed vs. unemployed

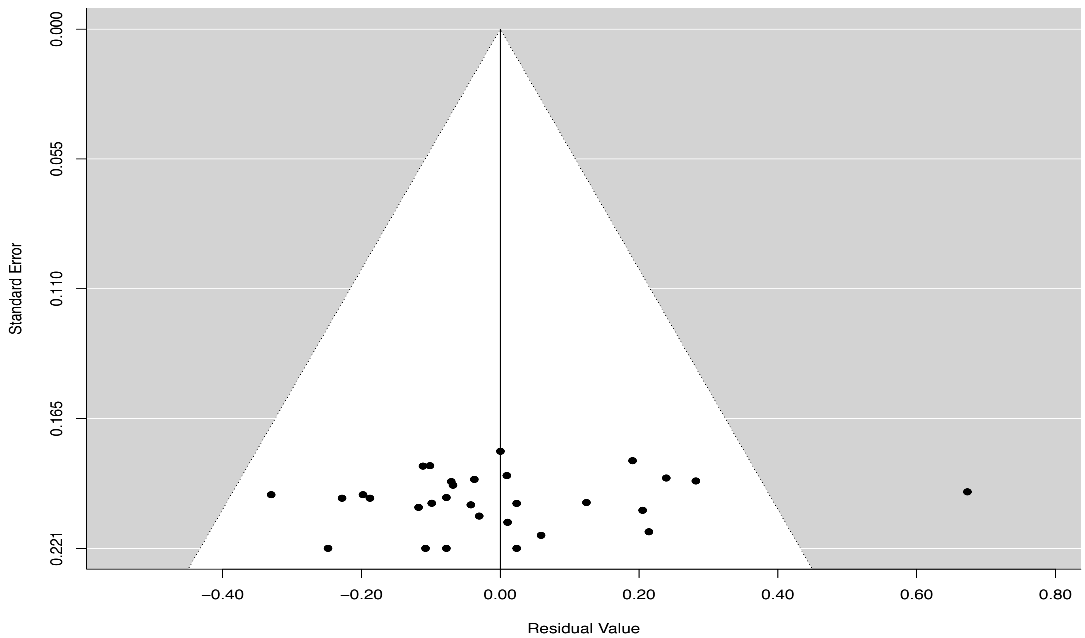

Figure 67. Funnel plot for subjective norm-behaviour moderated by race